BLM

RAPID ECOREGIONAL ASSESSMENT of the Northern Basin and Range and Snake River Plain

2009

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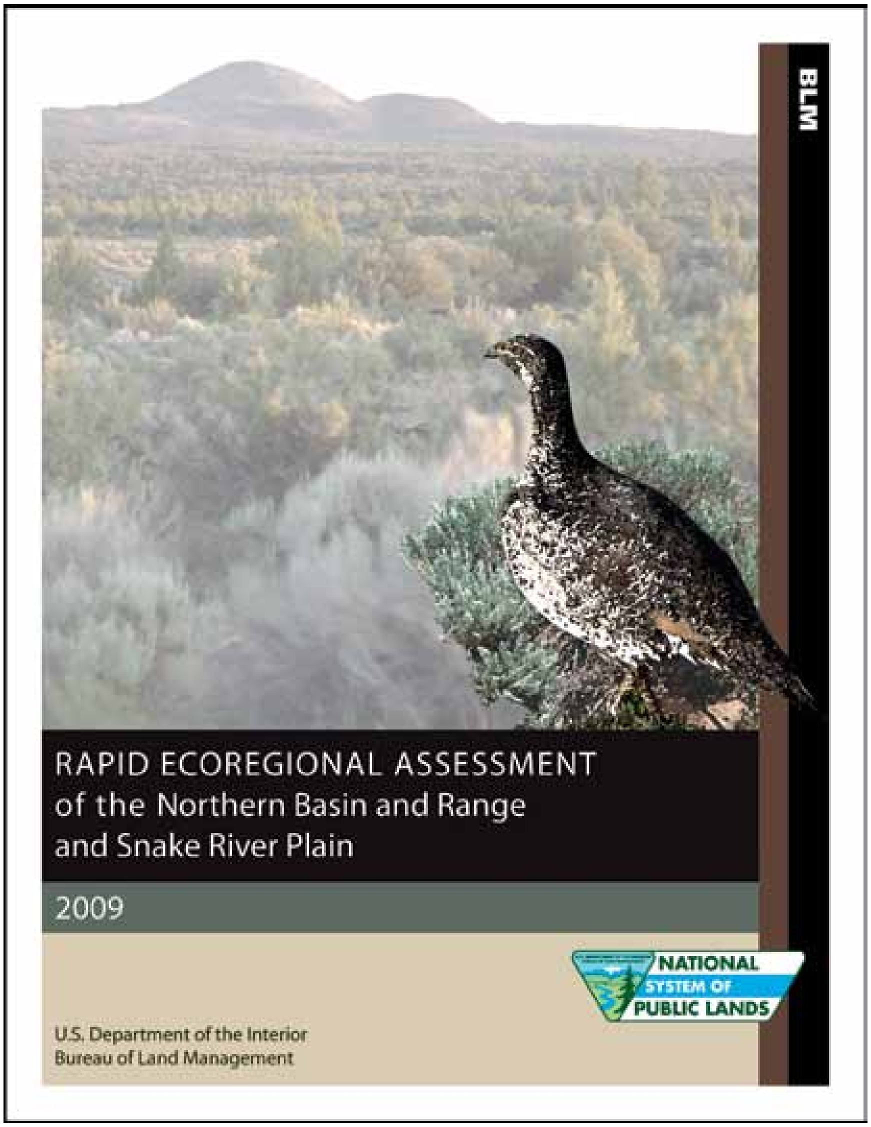
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PREFACE

In 2007, the Bureau of Land Management (BLM) established the Oregon/Idaho/Nevada Cooperative Shrub-Steppe Restoration Partnership in response to the BLM's Healthy Lands Initiative (HLI). The primary purpose of the HLI and the Partnership is to enable BLM to set land treatment priorities across a broader scale and unite land management agencies, private landowners, and other partners in an effort to protect, enhance, and restore sagebrush habitats on a landscape scale. Through HLI, funding was provided for large landscape projects that included matching contributions from partners. The Partnership's priorities have been to protect large intact sagebrush habitats, enhance these habitats, and lastly, restore degraded habitats. In addition, the Partnership is focusing management actions on areas that are at risk and have conditions with a high likelihood of success.

Given previous restoration work over the past 20 years within the Great Basin and Snake River Plains, BLM managers recognized that given limited resources, the extent of sagebrush habitat, the scale of threats or change agents occurring on public lands, and the effectiveness of existing management strategies, a larger regional assessment of sagebrush habitat was needed. Initial objectives for this assessment involved mapping several ecological/resource values and change agents, including: the current extent of sagebrush, juniper, and salt desert shrub; sagebrush-juniper interface; location of greater sage-grouse habitat; location of mule deer winter range; location of large wildfires; and extent of cheatgrass (and potential for cheatgrass to expand).

In 2008, the Partnership expanded to also include Utah and California and initiated a rapid ecological assessment of the northern Great Basin. This rapid assessment would be conducted within an approximately 18-month period using readily available data. Given these parameters and the initial objectives identified, the rapid assessment would help provide a better understanding of the location and scale of current threats to sagebrush habitats on public lands in the northern Great Basin. It would also assist in prioritizing focus areas for protection and the effective scale of treatments to protect, enhance, and restore sagebrush habitats.

This rapid assessment is a coarse-scale snapshot in time and additional work will be required to improve the resolution, particularly of cheatgrass and juniper. In addition, state and field offices will need to use existing local data to "step down" the assessment (i.e., establish ecoregional direction) to provide additional consideration to such other resource values as aquatics and high-priority obligate species. This rapid assessment provides a baseline to compare values, conditions, and management priorities to other ecoregions, as well as provides local decisionmakers with preliminary information to plan, analyze, and implement management actions within a regional context. The assessment may be viewed as an iterative process to better understand and align natural resource management at the national, regional, and local scales.

The northern Great Basin rapid ecological assessment was a pilot project for the BLM. Future assessments may differ slightly in format and may be more extensive, building upon the foundation provided by this inintial rapid assessment.

ACKNOWLEDGMENTS

The initial ideas and concepts that came together in the genesis of the Rapid Ecoregional Assessment of the Northern Basin and Range and Snake River Plain (hereafter, Northern Great Basin or NGB) were the product of two main groups, the Oregon/Idaho/Nevada Cooperative Shrub-Steppe Restoration Partnership and the BLM's Healthy Land Initiative (HLI) Conservation Policy Team. The assessment itself was governed by a board of directors, conducted by a team of BLM staff and contractors, lead by a project manager, and advised by a broad ad-hoc network of technical and policy experts, scientists, and BLM deputy state directors. This is particularly noteworthy because participation was voluntary and was almost without exception an additional duty that participants embraced. People gave of their time, knowledge, and creativity because they felt this was the right thing to do and they sincerely wanted to make a difference. Acknowledgments and gratitude are due to everyone involved along every step of the way and to the families and loved ones who supported this effort even though it often meant late hours and time away from home.

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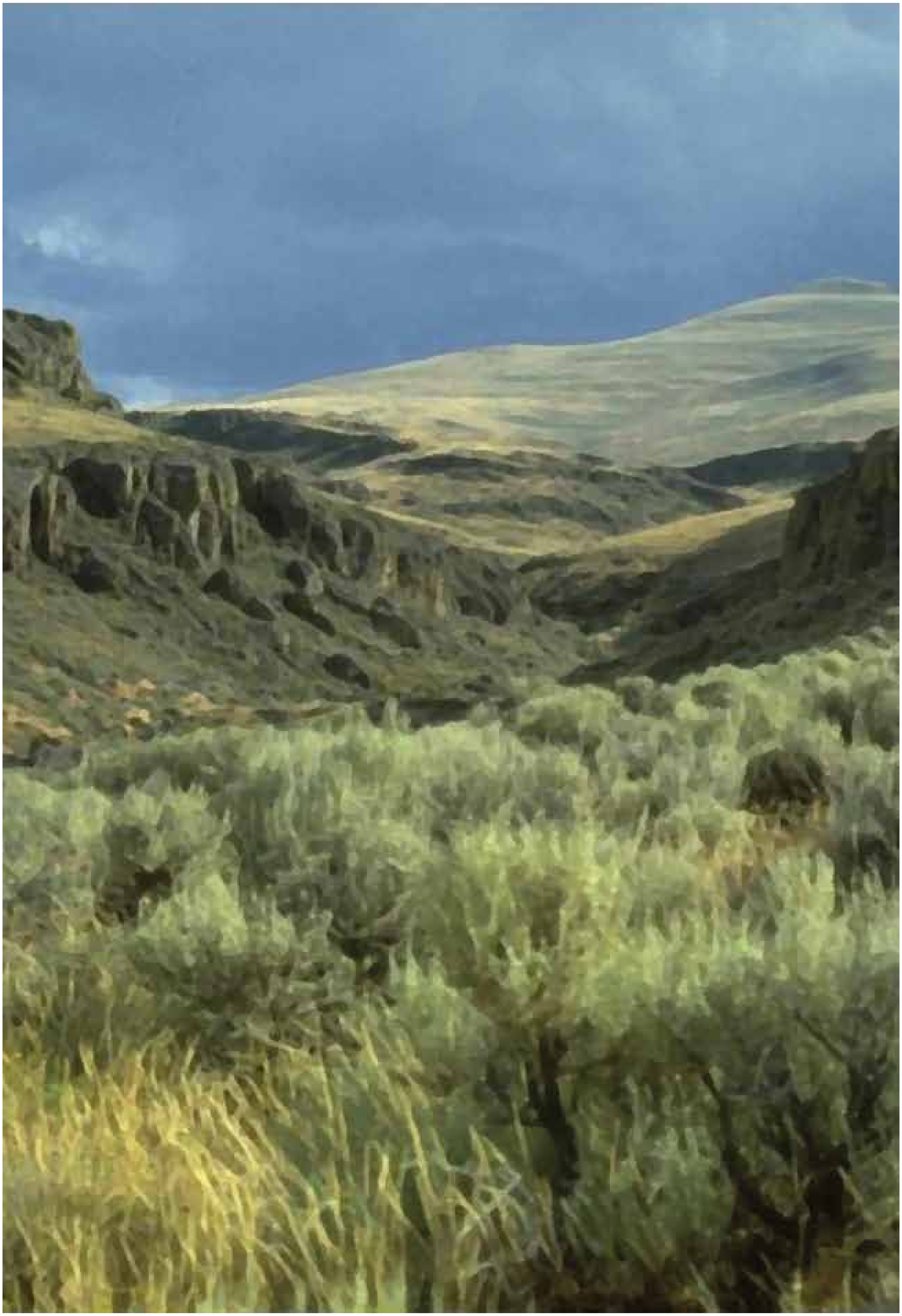

INTRODUCTION

Changes in sagebrush (*Artemisia* spp.), salt desert shrub, and pinyon-juniper plant communities since settlement of the Great Basin have resulted in altered fire regimes, spread of exotic annual grasses (i.e., cheatgrass or *Bromus tectorum*), and shifts in wildlife habitats and populations. Miller et al. (2008) indicate the lack of active management will potentially result in the continued decline of historic sagebrush communities, structural diversity, understory species, herbaceous production, habitat for sagebrush obligates, and landscape heterogeneity. State and Federal resource managers, landowners, nongovernment interests, and others throughout the region continue to advocate action to reverse trends toward sagebrush and salt desert shrub conversion to cheatgrass in areas burned by wildfire, sagebrush conversion to juniper in areas of fire exclusion, and resulting habitat losses for greater sage-grouse (*Centrocercus urophasianus*) and mule deer (*Odocoileus hemionus*). Efforts such as the Healthy Lands Initiative (HLI), which was launched by the U.S. Department of the Interior (USDI), have placed emphasis on an accelerated pace of priority setting and implementation of management activities at more broad landscape settings than previously available to promote management action in response to changes in natural resource values. For example, the Oregon/Idaho/Nevada Cooperative Shrub-Steppe Restoration Partnership is a component of the HLI and it emphasizes maintaining and restoring existing shrub-steppe plant communities and sagebrush-dependent animal species by addressing wildfire, cheatgrass, juniper dominance, greater sage-grouse, and mule deer concerns. The rapid ecoregional assessment of the Northern Basin and Range and Snake River Plain (hereafter Northern Great Basin or NGB) is intended to better inform management activities of that kind.

Purpose

The purpose of the NGB rapid ecoregional assessment is to demonstrate and document a large- (regional-) scale rapid spatial assessment of potential change in selected resource values as a result of certain change agents. Specifically, the focus of the assessment is on the current extent of sagebrush, juniper, and salt desert shrub; sagebrush-juniper interface; location of greater sage-grouse habitat; location of mule deer winter range; location of large wildfires; and extent of cheatgrass (and potential for cheatgrass to expand). The assessment identifies geographic-specific priority areas in the region and enables land managers to develop local management strategies and associated actions designed to ameliorate impacts from the identified change agents on the specified resource values.

Rapid Ecoregional Assessments

Rapid ecoregional assessment is one of a suite of tools and responses available to resource managers and field personnel for assessing natural resource values. Methods used are designed to augment knowledge and understanding to further establish baseline information about natural resources, assess changes in or the health of those natural resource values, and support their sustainable use. There is no single rapid ecoregional assessment method that can be applied to the wide range of natural resource values and for the variety of different purposes for which assessments are undertaken. Rapid assessment is defined as "a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its defined purpose" (Secretariat of the Convention on Biological Diversity 2006) and may be particularly relevant for assessing resource values that are distributed across large spatial scales, ecosystems, and administrative jurisdictions (Grech and Marsh 2008). Spatial-based assessments in geographic information systems (GIS) can assist in the rapid ecoregional assessment of potential for change to widely distributed species by incorporating spatially explicit models of species distribution. These models present qualitative and quantitative

information on the distribution of impacts from change agents considered to be hazards or threats (Pull and Dunning 1995). The approach has provided managers with maximum return for minimal investment in data collection by identifying priority areas where management intervention may yield the greatest positive result for the resource values of concern (Theobald 2003).

Management Questions

Perhaps the most important task during rapid ecoregional assessments is for BLM natural resource specialists and managers to identify preliminary management questions, which will help target subsequent assessment steps. Management questions, when answered by the assessment, will also help guide the BLM in formulating appropriate ecoregional responses and management strategies. The following are management questions identified by resource specialists and managers in the NGB:

1. *Where are sagebrush areas with potential for change to cheatgrass after disturbance from fire?*

2. *Where are greater sage-grouse currently occupied habitat areas with potential for change to cheatgrass after disturbance from fire?*

3. *Where are mule deer winter use areas with potential for change to cheatgrass after disturbance from fire?*

4. *Where are sagebrush-juniper interface areas with potential for change to cheatgrass after disturbance from fire?*

5. *Where are juniper areas with little potential for change due to fire exclusion?*

6. *Where are salt desert shrub areas with potential for change to cheatgrass after disturbance from fire?*

7. *Where are sagebrush-juniper interface areas with potential for change to juniper?*

8. *Where are greater sage-grouse currently occupied habitat areas in sagebrush-juniper interface areas with potential for change to juniper?*

Sagebrush and Cheatgrass Conversion

The magnitude of the expansion and increasing dominance of invasive cheatgrass in the Great Basin, and its attendant effects on native ecosystems through the grass-fire cycle, makes this possibly the most significant plant invasion in North America (Mack 1986; Billings 1990; D'Antonio and Vitousek 1992; Knapp 1996). The ability of cheatgrass to outcompete native species for available nutrients and water and its propensity to quickly colonize open niches in an ecosystem as a result of a disturbance event (e.g., fire, overgrazing) have greatly stressed the native sagebrush shrub-steppe ecosystem in the NGB (Brooks et al. 2004). The dominant sagebrush ecosystems in the region are fire prone and, prior to European settlement (circa 1860), exhibited fire return intervals ranging from 30 to 110 years (Whisenant 1990). Cheatgrass was introduced into the region in the late 1880s and rapidly spread throughout rangelands degraded by severe overgrazing of cattle and sheep (Mack 1986). Fine fuels from cheatgrass resulted in more frequent fires (Whisenant 1990; Knapp 1996), and in some lower elevation sagebrush vegetation types, a cheatgrass fire cycle now exists in which fires burn as often as every 3 to 5 years (Whisenant 1990, Brooks and Pyke 2001). Suring et al. (2005) has estimated that over 40 percent of the current area of sagebrush is at moderate to high risk of displacement by cheatgrass in the next 30 years. In big sagebrush (*Artemisia tridentata*) systems, expansion and dominance of cheatgrass have been greater in lower elevation Wyoming sagebrush types than in higher elevation mountain big sagebrush and mountain brush systems. The current distribution of cheatgrass indicates that, while the species is abundant and widespread at lower elevations, invasion of high elevation *A. tridentata* systems has been minimal (Suring et al. 2005). Chambers et al. (2007) concluded the invasibility of Great Basin sagebrush ecosystems by cheatgrass is dependent on environmental characteristics and is the result of several interacting factors, including precipitation and temperature regimes, site conditions, past and present disturbance, and the competitive abilities of the resident species. Cheatgrass invasiveness is limited by temperature at upper elevations; however, precipitation, with its effects on soil water, appears to be the primary control when temperature is not a factor. On an individual site basis, soil properties such as texture and depth significantly affect cheatgrass invasiveness. Past research has shown that soil water availability is the primary determinant of plant establishment processes in Great Basin ecosystems (Chambers 2000, 2001; Chambers and Linnerooth 2001; Humphrey and Schupp 2004).

Juniper and Juniper Expansion (Sagebrush-Juniper Interface)

Juniper and pinyon woodlands in the Intermountain West occupy over 18 million hectares (44,500,000 acres) (Miller and Tausch 2001). These woodlands are commonly associated with sagebrush communities forming a mosaic of shrub-steppe and woodlands across landscapes. Numerous studies have documented the expansion of these woodlands resulting in the replacement of shrub-steppe (sagebrush) communities (Adams 1975; Burkhardt and Tisdale 1976; Cottam and Stewart 1940; Gedney et al. 1999; Miller et al. 1999, 2005; Miller and Rose 1995; Tausch and West 1988, 1995; Tausch et al. 1981). The increase in juniper and pinyon dominance within Intermountain plant communities can have significant impacts on soil resources, plant community structure and composition, forage quality and quantity, water and nutrient cycles, wildlife habitat, biodiversity, and fire severity and frequency (Miller et al. 2005; Miller and Tausch 2001). Miller et al. (2008) conducted six woodland studies within the NGB region and adjacent areas and reported that juniper and pinyon woodlands across all sites sampled were of relatively low density with limited rates of establishment for over 200 years prior to settlement. Their findings supported contrasting studies of the postsettlement era suggesting substantial increases in juniper and pinyon have occurred in the Intermountain Region since the late 1800s. Since 1860, woodlands expansion across the six woodlands studies has resulted in the replacement of sagebrush-steppe plant communities. Increases were the result of both infill in mixed-age tree communities and expansion into shrub-steppe communities that did not previously support trees. The shift from a relatively stable or limited rate of establishment to a substantial increase in conifer establishment in both space and time is generally attributed to the reduced role of fire, introduction of domestic livestock grazing, and shifts in climate (Burkhardt and Tisdale 1976; Heyerdahl et al. 2006; Miller et al. 1999; Tausch 1999). Under current conditions, conifers are likely to continue expanding into shrub-steppe plant communities (Betancourt 1987; Miller et al. 2000; West and Van Pelt 1986).

Salt Desert Shrub and Cheatgrass Conversion

Just as dominance of cheatgrass promotes fire in sagebrush steppe ecosystems, salt desert shrub ecosystems dominated by nonnative annual grasses are more flammable than those dominated by native species (Brooks 1999). Fires were historically infrequent in salt desert shrublands. Desert shrublands usually lack sufficient fine fuels to carry fire, with widely spaced shrubs and bunchgrasses and relatively bare interspaces (Brooks 1999; Brooks and Pyke 2001; Emmerich et al. 1993; West 1983, 1994). In recent decades, cheatgrass has begun to dominate many arid sites in salt desert shrub and shadscale communities that receive 6-8 inches of annual precipitation and high-elevation areas that exceed 25 inches of annual precipitation (Daubenmire 1970; Mosely et al. 1999). Following 2 or more years with above average precipitation, sufficient fine fuel may be present to sustain a wildfire (Knapp 1998) and convert salt desert shrub communities to cheatgrass indefinitely (Pellant and Reichert 1984).

Greater Sage-Grouse and Habitat Loss

Greater sage-grouse are dependent on sagebrush-dominated habitat for food and cover during all periods of the year and are considered a sagebrush obligate (Connelly et al. 2000). "Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats" (Connelly et al. 2004), using a large-scale analysis approach, reported populations have undergone long-term declines. Sagebrush-dominated habitats

on which sage-grouse depend have been extensively altered and lost due to disturbance, land use, and invasion by exotic plants. More specifically, Connelly et al. (2004) reported the following contributing factors that collectively influence sagebrush-dominated habitat across the current distribution of sage-grouse: wildfires, cheatgrass in more arid lower elevation areas, conifer encroachment in moist higher elevations, land conversions (e.g., agriculture, urbanization, road networks, powerlines, railroads, communication towers), livestock grazing, and energy development (e.g., well pads, roads, pipelines, associated noise). During 2007 alone, the effect of large wildfires on greater sage-grouse was significant because of habitat loss and conversion to cheatgrass in Nevada (pers. comm. Sean Espinosa, Sage-Grouse Coordinator, Nevada Division of Wildlife). The U.S. Fish and Wildlife Service (USFWS) found substantial information indicating that listing of the greater sage-grouse as a threatened or endangered species under the Endangered Species Act may be warranted and initiated a status review (Federal Register 2004). Subsequently, the USFWS announced a 12-month finding that listing was not warranted while encouraging continued and enhanced conservation efforts (Federal Register 2005). Greater sage-grouse remain a species widely considered in scientific and public arenas to be of significant conservation concern (Stiver et al. 2006).

Mule Deer and Habitat Loss

Management of mule deer habitat and populations continues to be an important emphasis of State and Federal agencies in the Great Basin. Most mule deer in the region are migratory, although some populations remain all year on areas used as winter ranges by migratory animals. The availability and condition of Great Basin shrub-steppe habitats on winter ranges, and montane shrubs at higher elevations, are the most important limiting factors for mule deer in the Great Basin. The most important winter use areas are dominated by big sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia* spp.), and mountain mahogany (*Cercocarpus* spp.) (Kucera and Mayer 1999). Maintaining the quantity and quality of these crucial mule deer use areas is a continuing source of concern because of the present day fire-cheatgrass cycle and associated habitat loss to wildfires in relatively arid areas.

METHODS

Assessment Area

The NGB assessment area is coincidental with the Northern Basin and Range and Snake River Plain level III ecoregions of the Commission for Environmental Cooperation (CEC) ecoregional classification system (CEC 2006) and designated by the United States Environmental Protection Agency (EPA). The analysis area is over 48,390,000 acres (over 19,583,000 ha) in size, encompassing areas within the States of California, Idaho, Nevada, Oregon, and Utah (figure 1).

The Northern Basin and Range and Snake River Plain ecoregions contain plains (including dissected lava plains), rolling hills, alluvial fans, valleys, and scattered mountain ranges in the northern part of the Great Basin (McGrath et al. 2002; Thorson et al. 2003; Woods et al. 2001). Many of the alluvial valleys bordering the Snake River are used for agriculture (Thorson et al. 2003), and dryland and irrigated cropland are found in some areas of both ecoregions. Their southern boundary is determined by the highest shoreline of Pleistocene Lake Bonneville (McGrath et al. 2002; Woods et al. 2001). The western part of the region is internally drained; its eastern stream network drains to the Snake River system (Bryce et al. 2003).

The ecoregions support sagebrush steppe or saltbush vegetation; barren lava fields and saltbush-greasewood associations also occur (Bryce et al. 2003; McGrath et al. 2002; Thorson et al. 2003; Woods et al. 2001). Juniper-dominated woodlands occur on rugged, stony uplands. The mountain ranges are covered in mountain sagebrush, Idaho fescue, Douglas-fir, subalpine forests, or aspen (Woods et al. 2001). Today, much of the region is used for livestock grazing (McGrath et al. 2002; Thorson et al. 2003). Most public lands in the region are managed by the Bureau of Land Management.

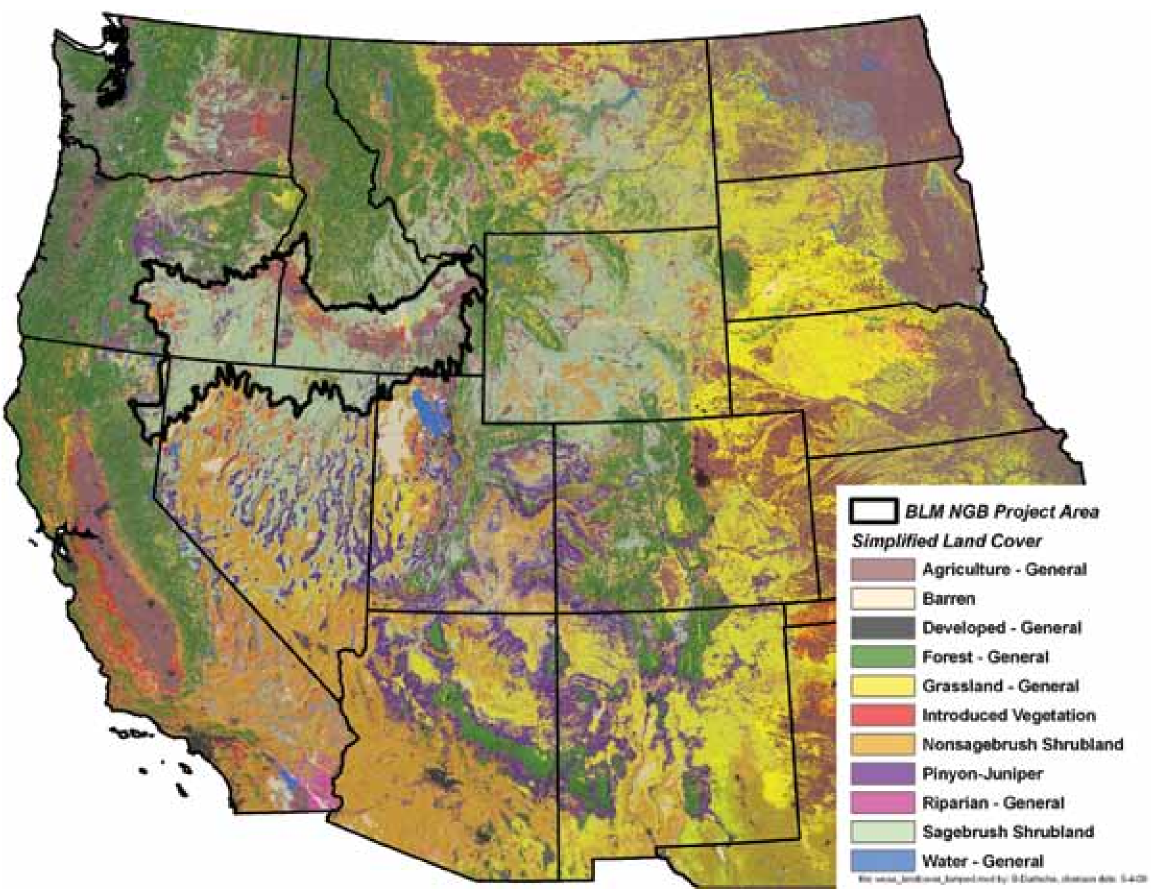

Figure 1. Rapid ecoregional assessment area (BLM NGB project area).

Overall Rapid Ecoregional Assessment Approach and Design

Three stages were used to conduct the rapid ecoregional spatial assessment: design/preparation, implementation, and reporting. Each stage is divided into steps:

Stage 1: Design/Preparation.

Step 1: Define the purpose and type of assessment. Assessment types could include resource-/species-specific assessments, baseline inventories, change assessments, indicator assessments, or natural resource sustainability assessments (Secretariat of the Convention on Biological Diversity 2006). This step included an appraisal of the time, money, and expertise available because limitations on those resources defined the scope of the effort. Scope included the methodology, natural resources and related activities of concern (i.e., plant communities, animal species, hazards/threats), geographic scope and site (i.e., NGB region), data collection, and data analysis.

Step 2: Acquire, develop, and critique relevant existing data and information to determine the extent of knowledge and information actually available. This assessment used best available existing data and information for analysis; no new information was required to conduct the actual data analysis.

Step 3: Design the assessment. This step involved the review of existing assessment methods and sought expert technical advice to choose the specific data analysis methodology suitable to produce the needed assessment product. The time schedule, data management requirements, and final determination of availability of time, money, and expertise were also accomplished during step three.

Stage 2: Implementation.

Step 4: Analyze spatial data and prepare metadata. This rapid resource-/species-specific assessment applied a prescriptive, predominantly deterministic spatial data analysis methodology to:

a. Determine the status of the plant communities and animal species of concern by locating and quantifying the amount of exposure to identified hazards (e.g., threats, stressors).
b. Estimate the relative level of risk from the hazards.
c. Identify opportunities to locally identify and implement specific actions and projects within the regional-level framework of geographic priority areas (e.g., emphasis areas) and accompanying strategies designed to ameliorate identified risk.

The data analysis methodology was tested, reviewed, and adjusted during this step. Step 4 included a determination of the level of confidence in the findings relative to the purpose of the rapid ecoregional assessment. It also included a compilation of assumptions or limitations associated with the product.

Stage 3: Reporting.

Step 5: Report results. This step involved final review of the assessment product and procedures. It also involved estimating confidence in the data analysis results, incorporating necessary adjustments, developing metadata, and distributing results and data to the initial stakeholder (i.e., the BLM). Results were reported in the style and level of detail specified by the initial stakeholder. User support or assistance to the initial stakeholder and others during product use or implementation was provided on an as needed basis (e.g., land use planning, activity planning, National Environmental Policy Act [NEPA] analysis, monitoring, additional assessment, project planning, other activities) at the request of the initial stakeholder.

Data Themes

Published literature, experts, and stakeholders were used to identify existing data themes for the following ecological values and change agents (as well as linkages between ecological values and change agents):

(A) sagebrush
(B) juniper

(C) salt desert shrub
(D) sagebrush-juniper interface
(E) greater sage-grouse (i.e., currently occupied habitat)
(F) mule deer (i.e., winter use areas)
(G) large wildfire occurrence (i.e., fires that are greater than or equal to 1,000 acres are large contributors to acres lost and 95 percent of all acres lost to fire from 1991 to 2007 in the region are from fires greater than or equal to 1,000 acres)
(H) cheatgrass conversion after possible wildfire (i.e., as a function of Suring et al. 2005)

Sagebrush (Data Theme A), Juniper (Data Theme B), and Salt Desert Shrub (Data Theme C)

Five primary land cover datasets were available over the NGB study area at the time this project was launched. These include: 1) LANDFIRE Existing Vegetation Type (EVT) (USDI-USGS 2007), 2) Southwest ReGAP (SWReGAP) (Prior-Magee et al. 2007), 3) NWReGAP (Kagan et al. 2008), 4) Shrubmap (USDI-USGS 2005), and 5) National Land Cover Dataset (NLCD) (Homer et al. 2004).

All five have one thing in common; they use Landsat satellite data as the primary input for deriving the land cover data. Four of the five employ NatureServe's ecological systems (Comer et al. 2003) as the classification scheme. All five employ classification and regression trees (CART) as the primary mapping algorithm. However, NWReGAP and Shrubmap both extensively modified their protocols to meet specific local phenomena. NWReGAP also extracted data from NLCD, LANDFIRE, and Shrubmap under certain criteria.

Land cover data quality for each dataset was evaluated by the BLM National Operations Center (NOC) using six criteria: accuracy, precision, relevance, completeness, consistency, and currency. Based on these evaluation criteria and expert input from various stakeholders associated with this assessment, it was decided to use NWReGAP for the northern States, SWReGAP for the southern States, and LANDFIRE EVT for all other non-GAP pixels in the analysis area (part of northern California only) (figure 2). This decision was driven primarily by the perceived and documented error levels of the various products.

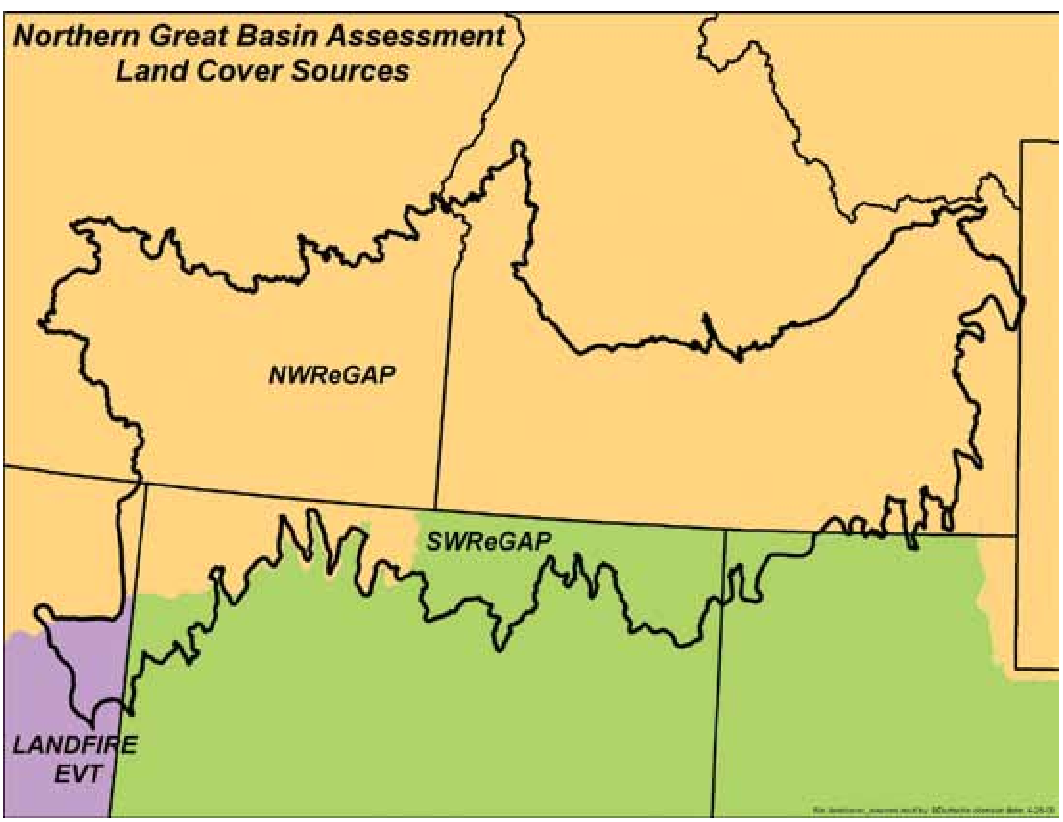

Figure 2. Land cover data sources.

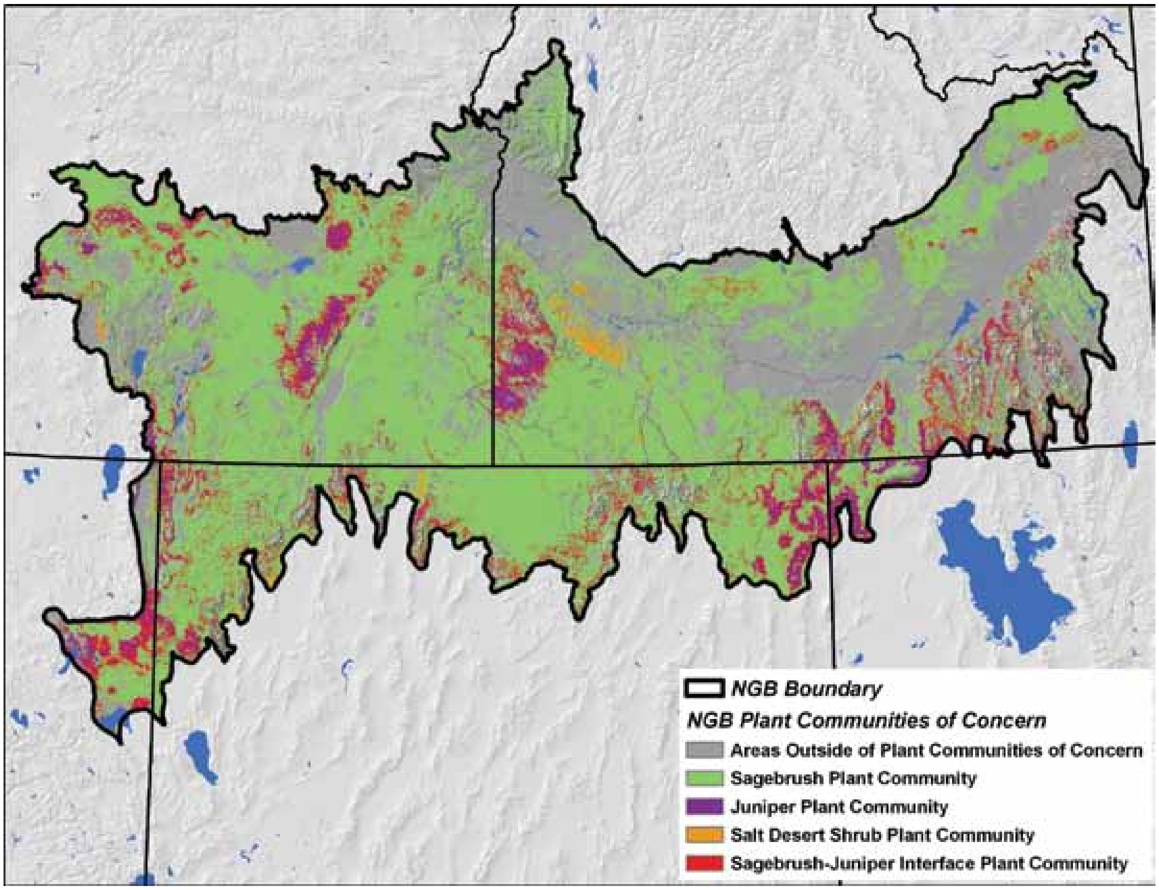

Figure 3. NGB plant communities of concern.

To build the final seamless raster representing plant communities of concern (PCC) for sagebrush, juniper, salt desert shrub, and sagebrush-juniper interface (potential juniper expansion in sagebrush), an integrated land cover grid was constructed in ArcInfo GRID at a cell size of 30 meters (figure 3). The integrated land cover grid was clipped to the NGB analysis area defined by combined CEC level III ecoregions labeled Snake River Plain and Northern Basin and Range. Specific land cover classes representing each of the plant communities of concern identified for the assessment were reclassed to a coded value and extracted. The complete list of original data sources, land cover classes, and coded values used in this analysis is presented in appendices 1, 2, and 3.

Sagebrush Juniper Interface (Data Theme D)

An interface between sagebrush and juniper was constructed and buffered by 120 meters into sagebrush to represent potential conifer expansion into sagebrush areas not discernible in Landsat satellite imagery. This distance was developed through an iterative process in which BLM Idaho sage-grouse habitat restoration mapping ("R-mapping" [Lysne and Pellant 2004]) polygons (specifically conifer encroachment polygons) were matched to different buffer distances from the sagebrush-juniper interface boundary until a visual estimate of best fit was achieved.

The Idaho potential restoration areas dataset is a midscale polygonal mapping product that identifies perennial grasslands, annual grasslands, and conifer encroachment areas for potential restoration of key sage-grouse habitat. Accuracy and precision of the map varies. Some polygons, such as certain perennial or annual grasslands resulting from recent wildfires reflect relatively high precision and accuracy since boundaries of BLM rangeland wildfires are routinely mapped using global positioning system (GPS) and GIS technology. Large areas of the map, however, represent only the best current approximation of general habitat status based on interdisciplinary

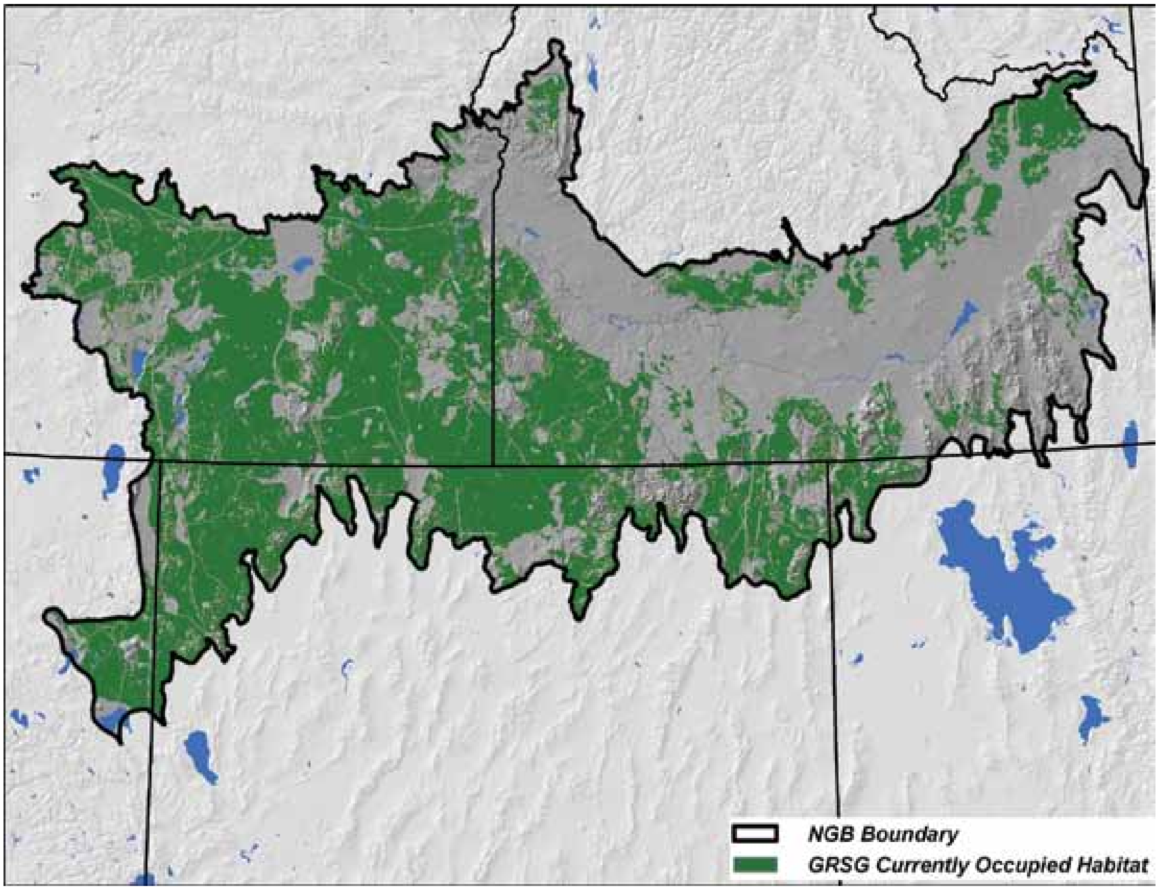

Figure 4. Greater sage-grouse currently occupied habitat.

or interagency input. Conifer encroachment areas are defined in the restoration product as "areas where junipers and/or other conifer species are encroaching into sage-grouse habitat areas."

The juniper-sagebrush interface was merged with the remaining sagebrush and juniper pixels, as well as the salt desert shrubs. In order to simplify the complexity of the raster product, a majority neighborhood function was passed over the resultant grid using an approximately 40-acre (13- by 13-cell) neighborhood to maintain a regional level of detail.

Greater Sage-Grouse (Data Theme E)

The model evaluated potential change to greater sage-grouse (GRSG) currently occupied habitat (January 2009) from large fires, cheatgrass, and conifer expansion (figure 4). These data have been modified from the original fall 2006 version; all currently occupied habitat within wildfire perimeters mapped in 2007 and 2008 by the Geospatial Multi-Agency Coordination Group (GeoMAC/USGS) was removed. Complete metadata is included with the dataset.

Mule Deer (Data Theme F)

The raster spatial dataset for mule deer winter use areas represents a combination of Utah State University and Western Association of Fish and Wildlife Agencies (WAFWA) mapped mule deer winter range and winter concentration areas (figure 5). Figure 5 is intended to depict critical mule deer habitat within the NGB assessment area. ArcInfo coverages representing mule deer winter range and winter concentration areas were extracted and combined. These two classes of mule deer habitat are defined as follows:

> ***Winter Range*** – That part of the overall range where 90 percent of the individuals are located during 5 average winters out of 10 from the first heavy snowfall to spring greenup, or during a specific period of winter. A subset of this

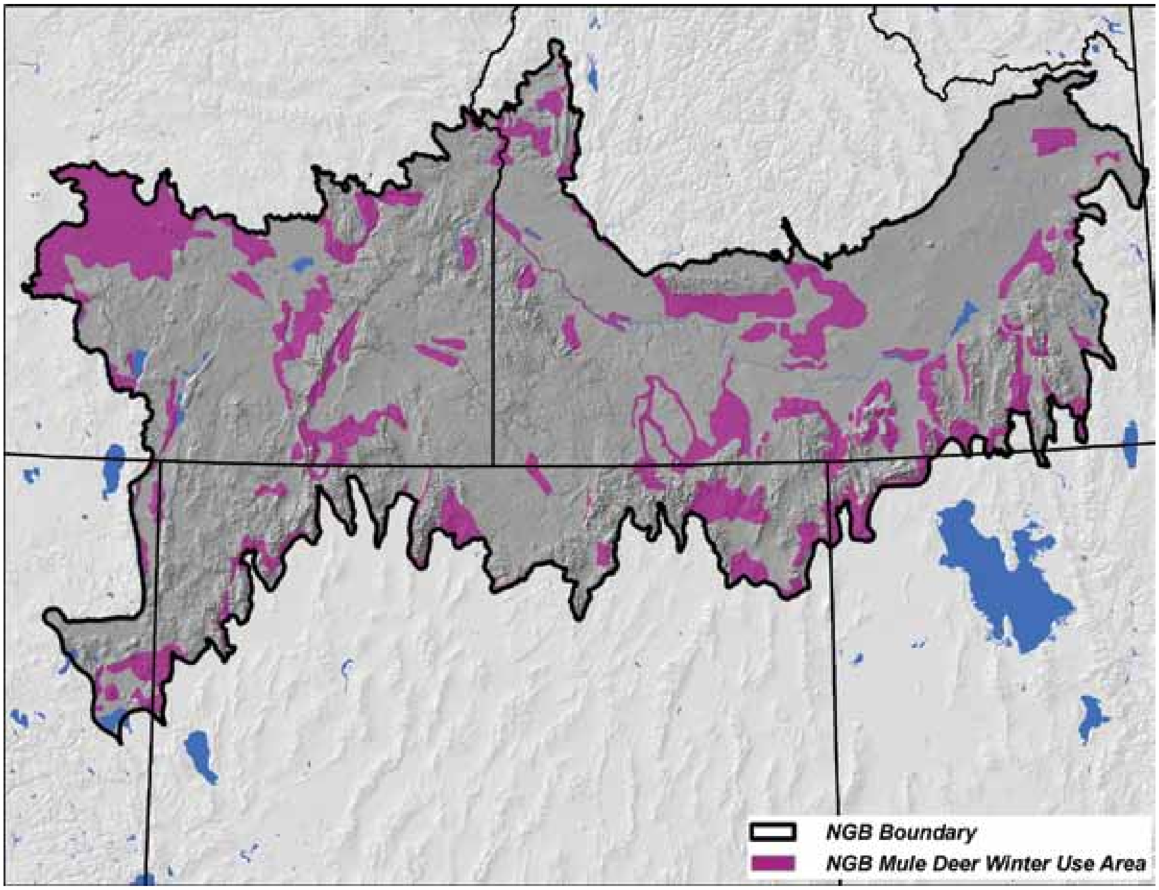

Figure 5. Mule deer winter use areas.

definition would be "severe winter range," which includes areas within the winter range where 90 percent of the individuals are located when annual snowpack is at its maximum and/or temperatures are at a minimum in the 2 worst winters out of 10.

Winter Concentration – This habitat includes that part of the winter range where densities are at least 200 percent greater than the surrounding winter range density during the same period used to define winter range in 5 average winters out of 10.

Fire (Data Theme G)

Large Fire Density. Relative to the Intermountain West, the NGB region possesses a very high proportion of large fires (figure 6). This circumstance contributed to the selection of large fire risk as an important component of the assessment. Risk for large fire was determined using the historical presence of large fires as a theoretical basis for predicting future large fire behavior. A simple test of large fire temporal dynamics was conducted to determine if the spatial location of large fires has changed from decade to decade (1991-2000 to 2001-2007) within the analysis area. Decadal change was found to be minor at the regional scale, suggesting that the fundamental prerequisites for large fire occurrence are not changing rapidly through this time interval.

A conceptual modeling approach was used to estimate large fire risk within the confines of this analysis, which involved determining the definition of a large fire, the spatial location of large fires using density of occurrence, and risk assignments. Empirical fire occurrence point data were used as the foundation for modeling. The fire occurrence product is a geospatial summary of fire occurrence reports from the U.S. Forest Service, Bureau of Indian Affairs, BLM, USFWS, and National Park Service for the period 1991-2007. This shapefile was clipped from a national dataset to the western U.S. All records representing prescribed fires, false alarms, or severity funds were removed. Kernel density was calculated from the filtered occurrence points to establish a spatial framework for assessing large fire risk. Fire occurrence records were selected and grouped into the standard A through G fire size class categories used by the National Wildfire Coordinating Group (NWCG). Densities were calculated separately and mapped for each group of occurrences greater than or equal to a given size class (e.g., all fires greater than or equal to 300 acres = E+F+G classes). Effectiveness of each size class in depicting large fire risk was evaluated by first scanning each density map for risk contrast. This resulted in the removal of size classes A (greater than or equal to 0.25 acre) through D (greater than or equal to 100 acres), which exhibit little to no risk contrast within the analysis area.

For the remaining three size classes (EFG, FG, and G), large fire density was evaluated regionally and, based on expert knowledge and opinion, it was concluded that the size class group of greater than or equal to 1,000 acres (F+G) best represents a balance between perceived current risk and potential future risk of large fires in areas that have heretofore not burned. This size class also enhances the interregion contrast for relative risk scoring purposes (e.g., Wyoming Basin is appropriately mapped as low risk for large fire using this size class). Fires greater than or equal to 1,000 acres in size are large contributors to acres lost, and 95 percent (8,485,803 acres) of all acres lost from 1991 to 2007 in the region were from fires greater than or equal to 1,000 acres. Wildfires with a size greater than or equal to 1,000 acres are therefore considered large fires for the purposes of this analysis. The greater than or equal to 1,000-acre fire density grid was contoured and, after significant discussion with experts and stakeholders, the 0.002 fires/sq km contour was selected as the cutoff for large fire risk versus typical fire risk. A simple Boolean risk definition was selected, (i.e., at risk for large fires or not at risk for large fires) due to the very general nature of this model. The model does not incorporate a large number of presently unquantifiable

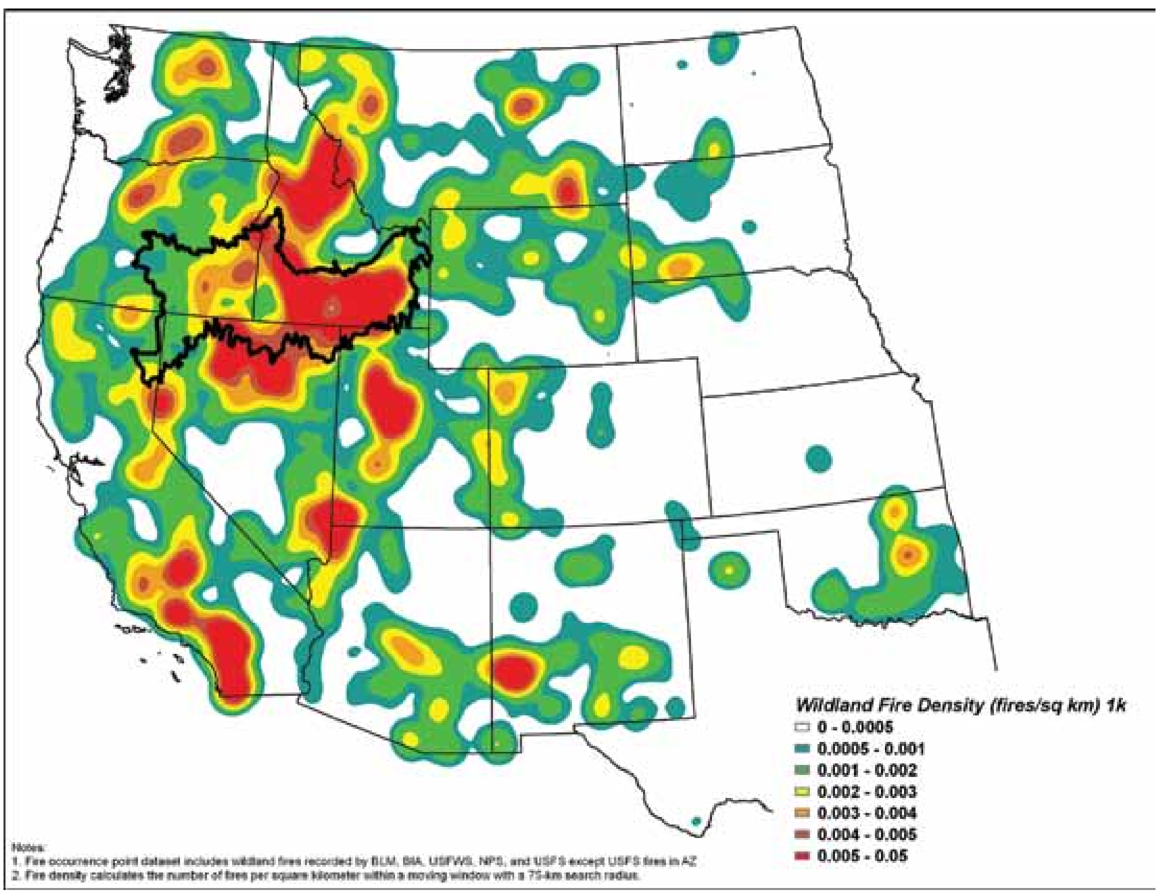

Figure 6. Fire occurrence density for wildland fires greater than or equal to 1,000 acres from 1991 through 2007.

variables (e.g., cheatgrass understory) related to large fire causal mechanisms; thus, assessing the accuracy of contour selections and fire size classes is not appropriate.

Fire Perimeters. Fire perimeters were obtained from GeoMAC (2001-2006), GeoMAC/USGS (2007-08), and BLM field offices (2001-06) (figure 7). The perimeters were attributed according to NWCG standards. Projection and topology were verified, and single fire versus fire complex issues were resolved. Files from 2001 to 2006 were projected and merged first. Then duplicate polygons were removed. A consistent year attribute was established for all polygons. Fires for the full year in 2007 through December 9, 2008, were then merged and attributed similarly. These data should not be considered complete, but they are considered a reasonable depiction of significant fires based on the requirements of the NGB assessment balanced with the short timeframe for this rapid ecoregional assessment.

These perimeters were used to remove pixels for PCC that were presumably consumed by wildfire, which assumes complete removal of these plants within the perimeter boundary. However, since there is overlap between the age of the wildfires and some of the satellite imagery used to construct the plant community data, it was deemed appropriate to ensure that all land cover already representing the presence of a fire (i.e., preimagery fires) be allowed to manifest themselves. To accomplish this, a visual scan was conducted of all fire perimeters displayed over land cover to determine which fires are already represented by land cover pixels ("recently burned" class). These fire perimeters were removed from the dataset to allow the land cover to more accurately depict the postfire condition of the landscape. The entire dataset was then dissolved to remove any overlapping fires and create a simple "cookie cutter" for removing target land cover classes from the model output in areas of postimagery fire. Over the span of postimagery

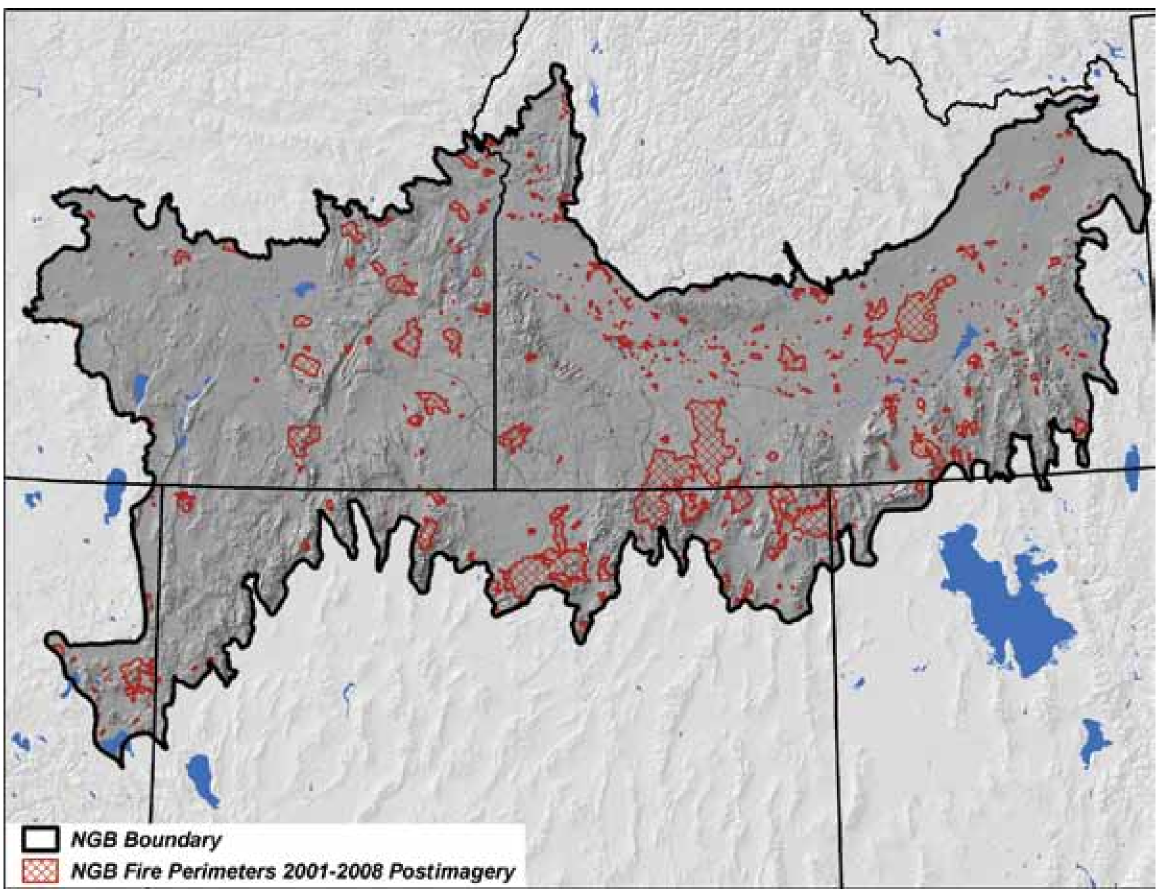

Figure 7. NGB fire perimeters 2001-2008.

fires from 2001 to 2008 within the assessment area, nearly 3,145,000 acres burned, and of this total, over 2,401,000 acres of PCC were removed. Eighty percent (1,921,000 acres) of the removal of PCC was in the sagebrush land cover group.

Cheatgrass (Data Theme H)

Cheatgrass Risk Model. The cheatgrass model developed for use in the NGB assessment was adapted from Suring et al. (2005) by the BLM NOC. It is designed to model risk of sagebrush and other native vegetation displacement by cheatgrass. Variables selected by Suring et al. (2005) included aspect, slope, elevation, and landform by ecological province. Changes made to the original Suring et al. (2005) model include: 1) PCC were derived from 30-meter GAP and LANDFIRE land cover data and include sagebrush, juniper, and salt desert shrub plant communities only, 2) the portion of the eastern NGB covered by the Wasatch ecological province is assumed to be a part of the northern ecological province for parameterization, and 3) ecological provinces not included in the original model were assumed to be part of the northern ecological province for parameterization.

Classes of risk for native vegetation displacement by cheatgrass as defined by Suring et al. (2005) are:

- ***Low Risk*** – The probability that cheatgrass will displace existing sagebrush or other susceptible cover types within 30 years is minimal; native plants are likely to dominate the understory of these stands at the current time.

- ***Moderate Risk*** – The probability that cheatgrass will displace existing sagebrush or other susceptible cover types within 30 years is moderate, but lower than for types at high risk; either cheatgrass or native plants can dominate the understory at the current time.

- ***High Risk*** – The probability that cheatgrass will displace existing sagebrush or other susceptible cover types within 30 years is very likely; cheatgrass is likely to dominate the understory (versus native plants) at the current time.

Potential Cheatgrass Conversion. Initial review of the Suring et al. (2005) cheatgrass risk model found that the extent of the raster product did not cover the entire NGB region. In order to map the area completely, the model was re-created using the same parameters as the original, but using a 30-meter minimum cell size rather than the original 90-meter size, and with GAP/LANDFIRE land cover rather than the original Sage Stitch data. Plant communities of concern (sagebrush, juniper, and salt desert shrubs) were the only land cover types evaluated in this analysis. The ecological province boundary shapefile was acquired from the authors, reprojected, and an attribute was added to distinguish between northern and southern ecological provinces as classified in Wisdom et al. (2005). The Wasatch province and those areas not covered by the original model were added as northern ecological province definitions. This product was then converted to a raster attributed by ecological province (northern or southern; figure 8).

Modeling based on each ecological province parameter set (table 1) was conducted by constructing a single raster from 30 meter digital elevation map (DEM) data. This very large grid combines elevation, aspect, and slope parameters for every pixel in the analysis area. Parameter risk valuations were added as new attributes by province.

In the southern ecological province, a valley floor landform parameter is also present. The valley floor is defined as an area greater than or equal to 40 hectares (99 acres) with a slope of less than 5 percent. A separate grid was constructed by selecting areas with flat aspect and a slope of less than 5 percent. A grouping function was passed over this to define approximately 40-hectare-minimum regions (21 by 21 pixels). Then mean elevations were calculated for these regions, and parameter risks were assigned. This product was compared with the base model to create the final southern ecological province model product.

Since the entire NGB had already been modeled in an earlier version to both northern and southern ecological province model parameters, each was clipped to the new raster boundaries for its respective province type. The two resultant rasters were merged to form the final product (figure 9).

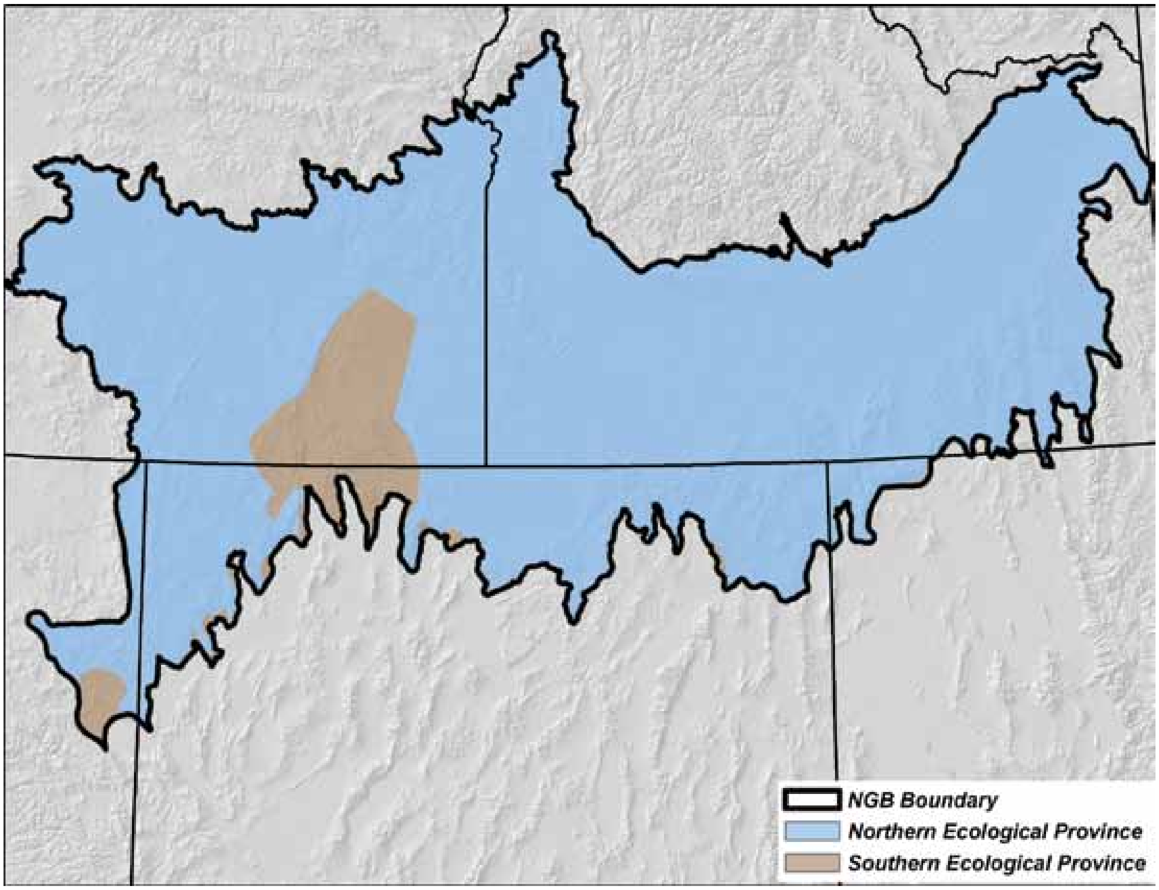

Figure 8. Northern and southern ecological province boundaries used in cheatgrass risk modeling adapted from Wisdom et al. (2005).

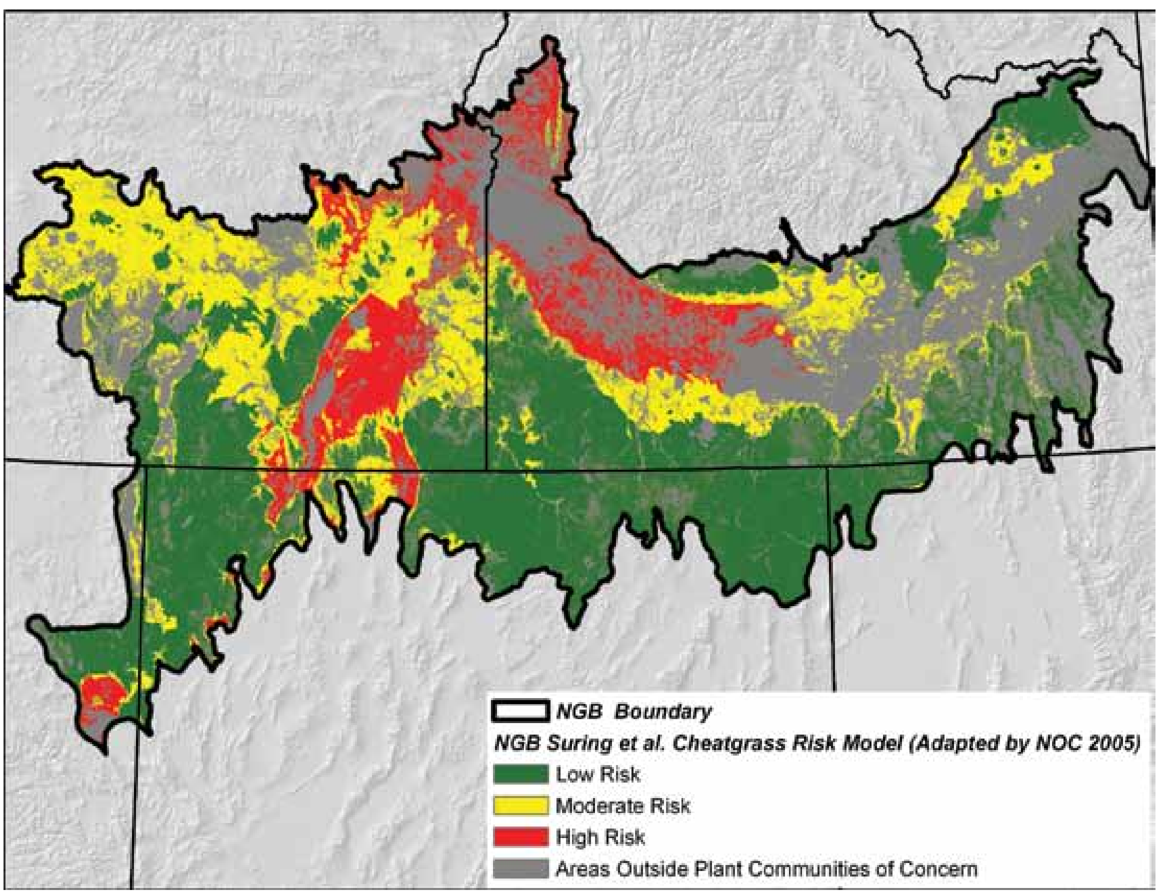

Figure 9. Cheatgrass risk levels (adapted from Suring et al. 2005).

Table 1. Rule set used for delineating cheatgrass risk for two groups of ecological provinces.

NORTHERN ECOLOGICAL PROVINCES	SOUTHERN ECOLOGICAL PROVINCES
John Day (1)	Lahontan (7)
Snake River (2)	Central High (13)
Mazama (3)	High Calcareous (11)
High Desert (4)	Mono (12)
Klamath (9)	White River (14)
Raft River (8)	Bonneville (10)
Humboldt (6)	Mojave (15)
Aspect NW – East (315-360˚ or 0-89˚) and Slope ≥ 30 Percent	
Elevations	Elevations
Low Risk: >4,000 ft (1219 m)	Low Risk: >5,000 ft (1524 m)
Moderate Risk: 3,000-4,000 ft (914-1219 m)	Moderate Risk: 3,000-5,000 ft (914-1524 m)
High Risk: <3,000 ft (914 m)	High Risk: <3,000 ft (914 m)
Aspect East – NW (90-314˚) and Slope ≥ 30 Percent	
Elevations	Elevations
Low Risk: >5,500 ft (1676 m)	Low Risk: >6,500 ft (1981 m)
Moderate Risk: 4,500-5,500 ft (1372-1676 m)	Moderate Risk: 5,500-6,500 ft (1676-1981 m)
High Risk: <4,500 ft (1372 m)	High Risk: <5,500 ft (1676 m)
Flat Aspect (-1˚) or Slope <30 Percent	
Elevations	Elevations
Low Risk: >5,000 ft (1524 m)	Low Risk: >6,000 ft (1829 m)
Moderate Risk: 4,000-5,000 ft (1219-1524 m)	Moderate Risk: 5,000-6,000 ft (1524-1829 m)
High Risk: <4,000 ft (1219 m)	High Risk: <5,000 ft (1524 m)
Valley Floor	
	Elevations
	Moderate Risk: ≥6,000 ft (1829 m)
	High Risk: <6,000 ft (1829 m)

Risk Exposure Quantification and Risk Estimation

Data sources for all raw data used in the assessment model are listed in appendix 1. The "Land Cover Data Quality Report" is included as appendix 4. The GIS datasets described in figures 3 through 6 and figure 9 were integrated to develop a single GIS risk raster dataset containing 96 unique combinations of resource values and change agent risks. This was done by concatenating the individual descriptive categories of each of the above datasets into one attribute data field describing all the values at each individual cell location. The product was then combined with the large fire boundary theme and all postimagery fire perimeters were used to cut out recently burned areas from the PCC. This geospatial product can be queried for different change agent risks and resource value combinations in order to quantify the hazards associated with plant communities and animal species of concern.

RESULTS

With the assistance of a GIS specialist, practitioners can readily use this product to identify a variety of priority areas they may consider for ecoregional management. Figures 10 through 21 illustrate the variety of possible combinations that may be applied to management questions and other information needs. Acreages are available by summing model attributes that can be customized via query to a specific priority area and associated management question.

Existing sagebrush plant community areas are the most widespread resource of concern within the NGB region (24,024,881 acres [9,722,524 ha]). Change agent risks to sagebrush are shown in figures 10 and 11. Understandably, a relatively large amount (19,568,462 acres [7,919,076 ha]) of greater sage-grouse currently occupied habitat is also present. Relative risks for cheatgrass conversion and large fire within currently occupied habitat are depicted in figures 12 and 13. Mule deer winter use areas comprise 6,475,002 acres (2,620,340 ha) in the region. Change agent risks to mule deer winter use areas are shown in figures 14 and 15. Sagebrush-juniper interface is present in 2,734,664 acres (1,106,679 ha) of the region. See figures 16 and 17 for cheatgrass conversion and large fire risk maps within the interface area. Juniper-dominated areas comprise 1,452,431 acres (587,778 ha) of the region. Figure 18 depicts large fire potential for juniper. Existing salt desert shrub communities are not abundant in the region (329,974 acres [133,536 ha]). Most of the salt desert shrub communities are located in areas with high potential for conversion to cheatgrass and high potential for large fires (figures 19 and 20). Figure 21 depicts a combination of all resource values with potential to change to cheatgrass in areas of high and low risk to large fires.

Six of the eight management questions were addressed with the geospatial data available. Table 2 provides a summary of the management questions addressed with associated data themes, acreage, percent of the NGB delineated, and a reference to the associated map(s). Overlap is summarized in table 3.

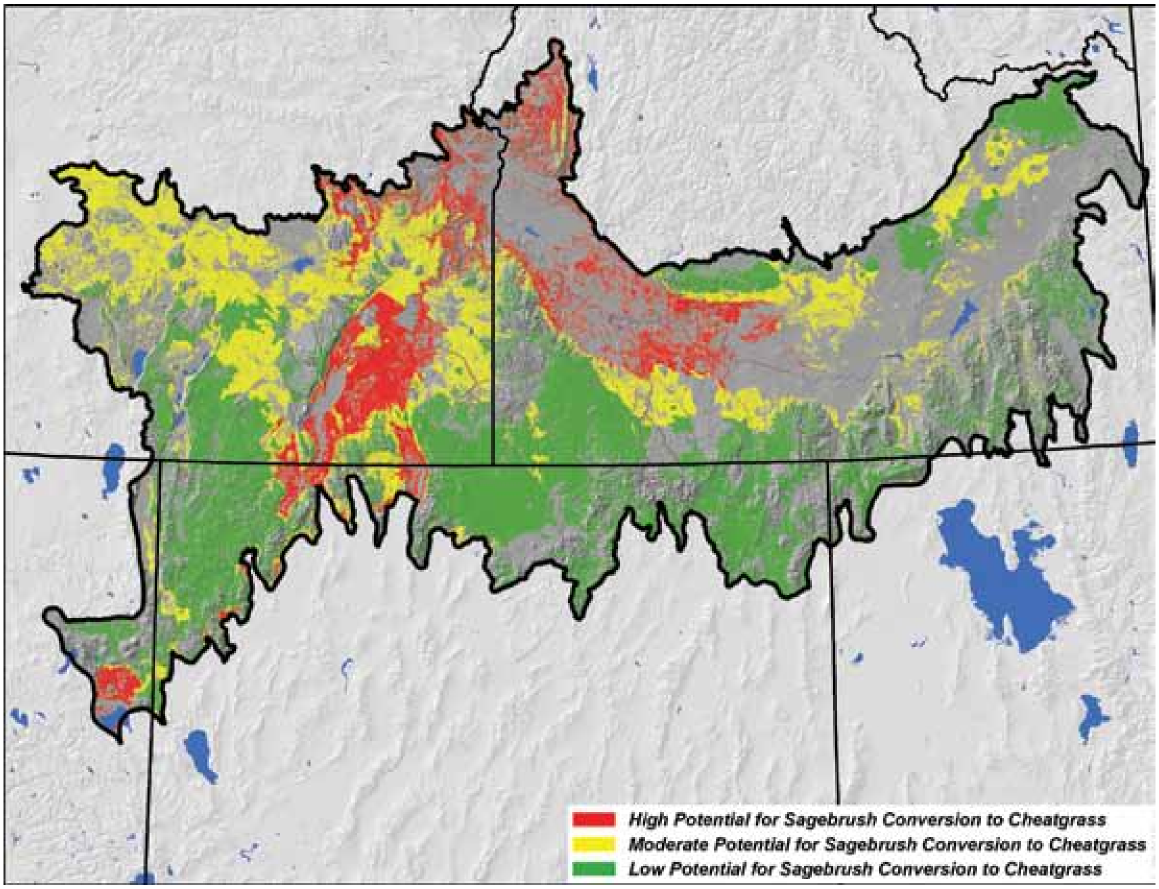

Figure 10. Potential for sagebrush conversion to cheatgrass in the NGB (adapted from Suring et al. 2005).

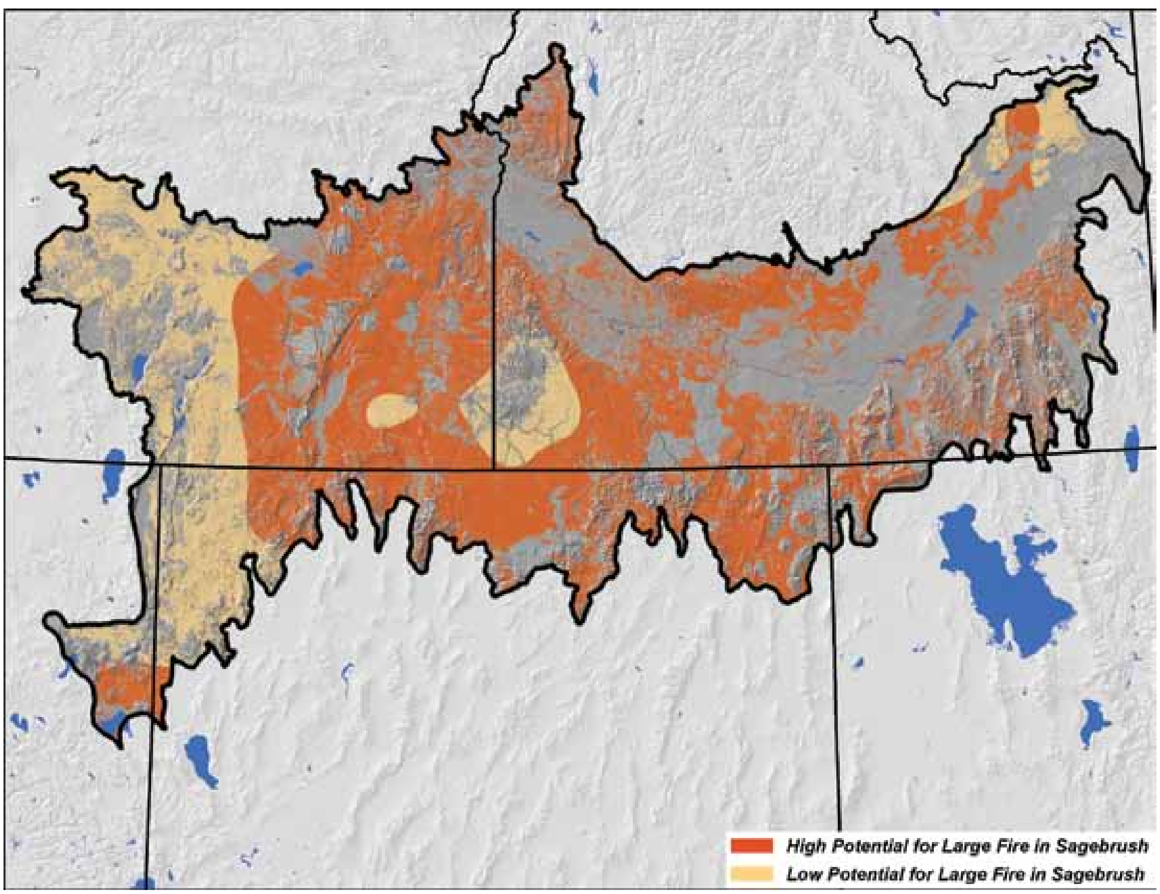

Figure 11. Potential for large fire in sagebrush in the NGB.

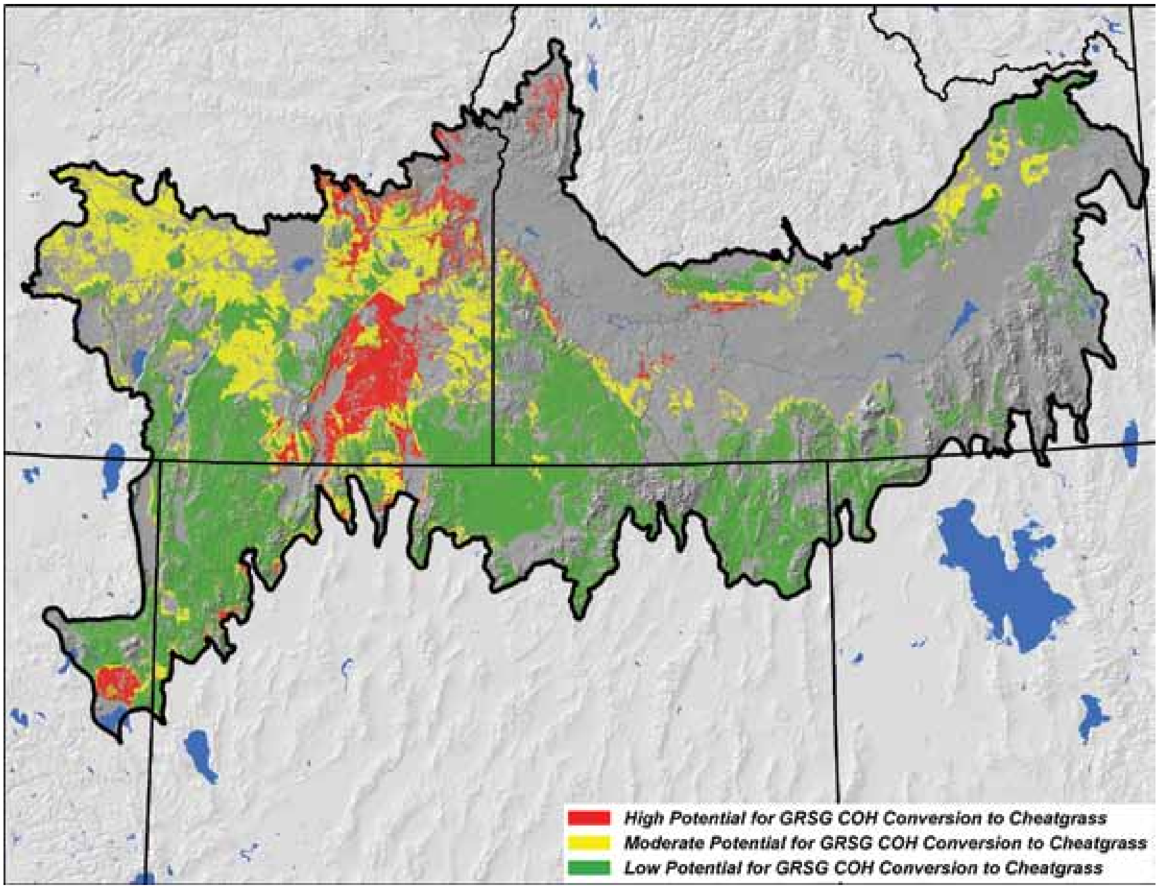

Figure 12. Potential for greater sage-grouse currently occupied habitat (COH) for conversion to cheatgrass in the NGB.

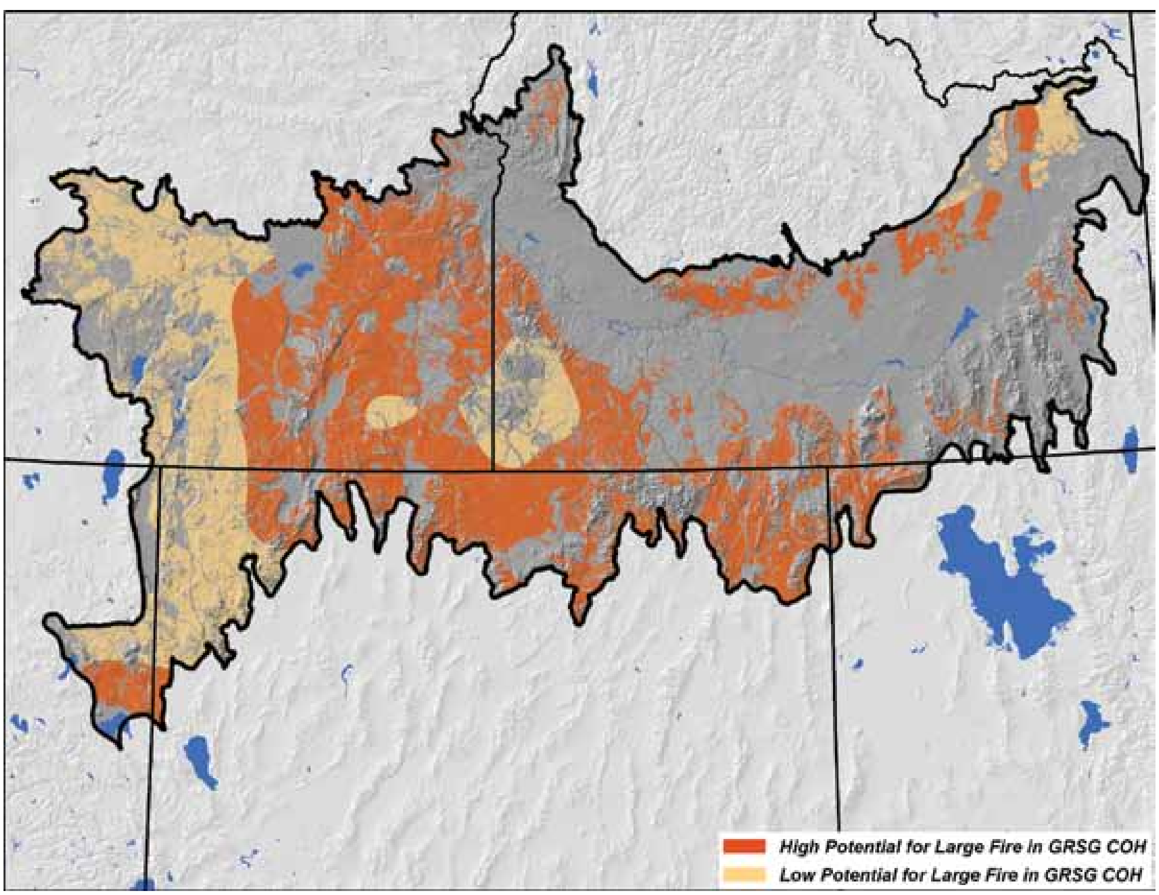

Figure 13. Potential for large fire in greater sage-grouse currently occupied habitat in the NGB.

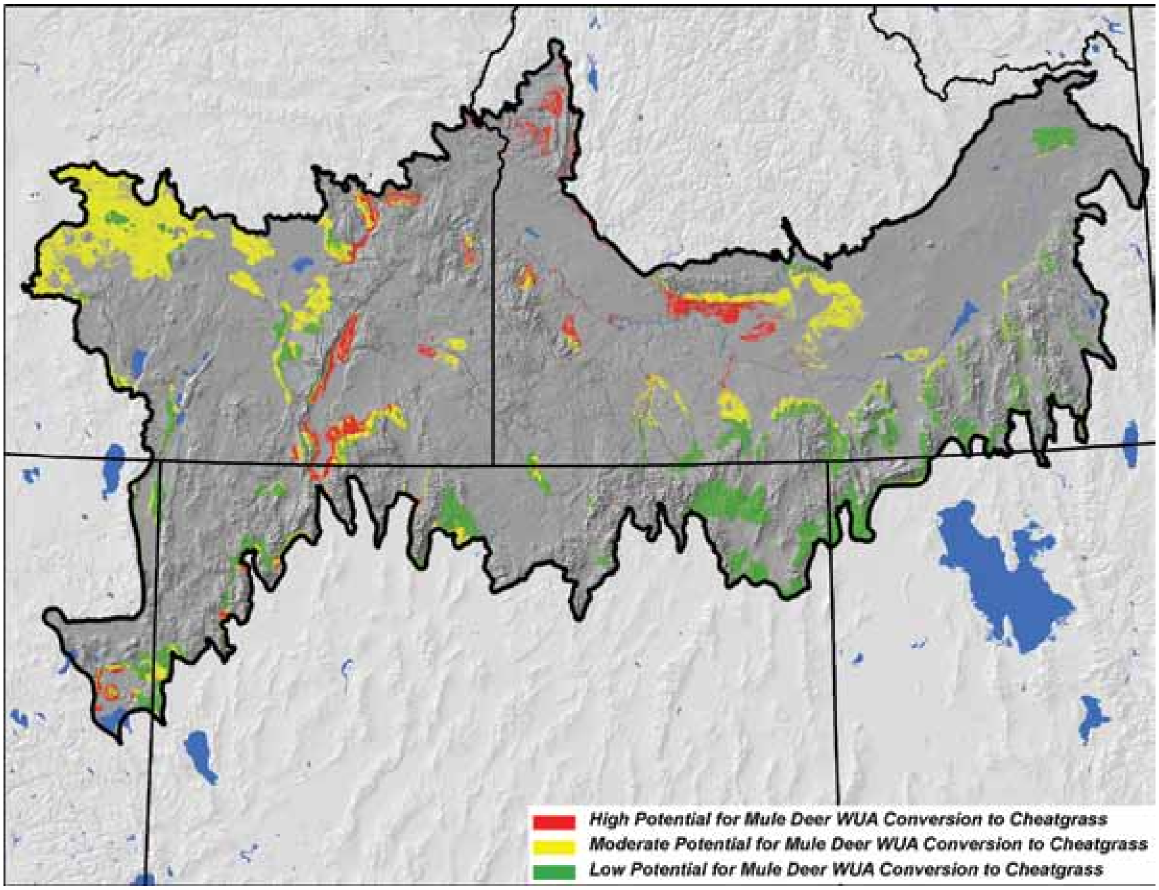

Figure 14. Potential for mule deer winter use area conversion to cheatgrass in the NGB.

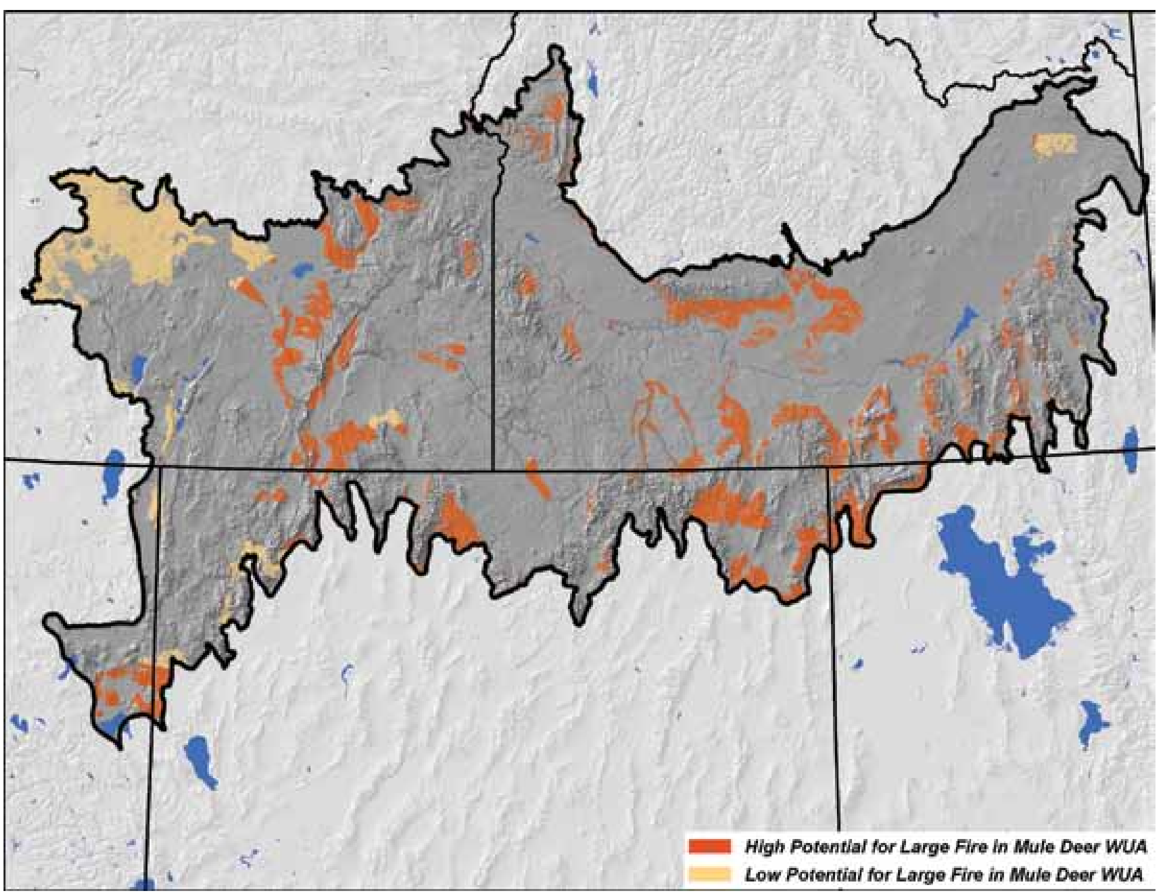

Figure 15. Potential for large fire in mule deer winter use areas (WUAs) in the NGB.

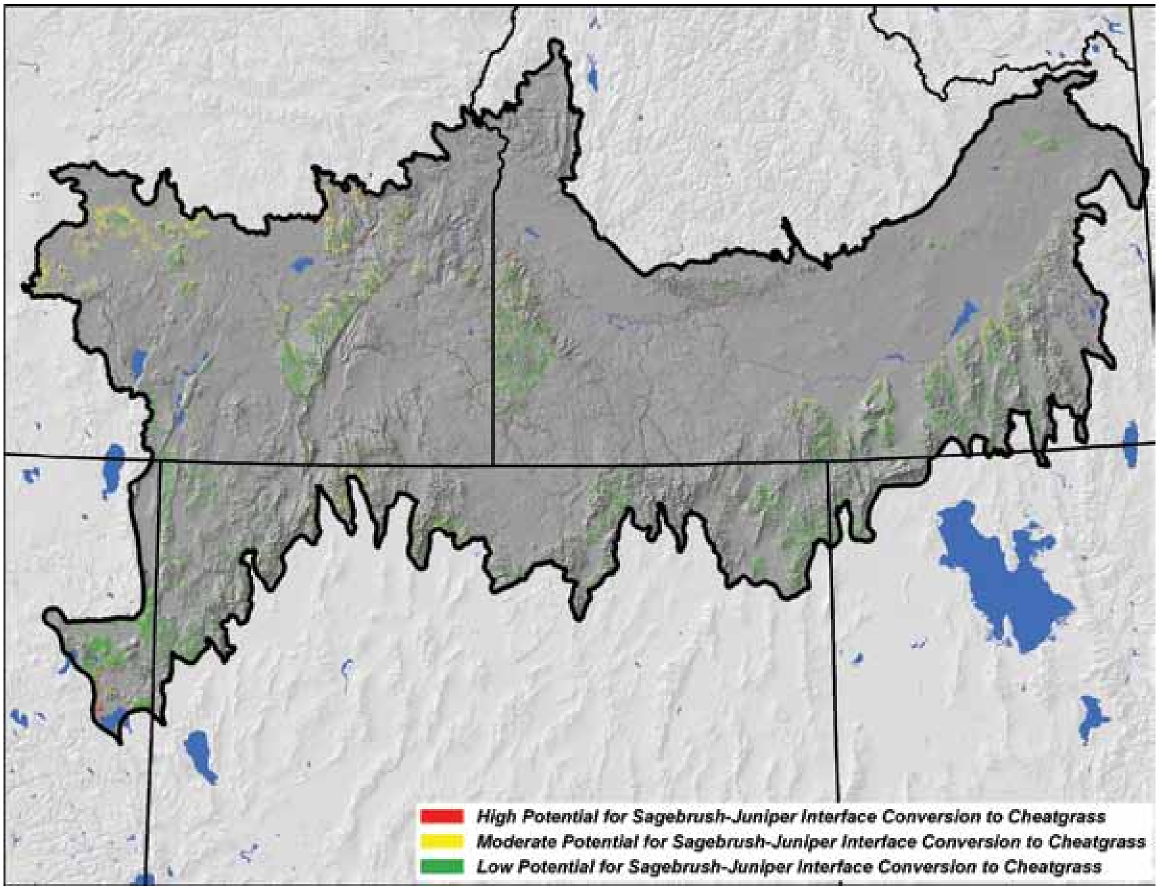

Figure 16. Potential for sagebrush-juniper interface for conversion to cheatgrass in the NGB.

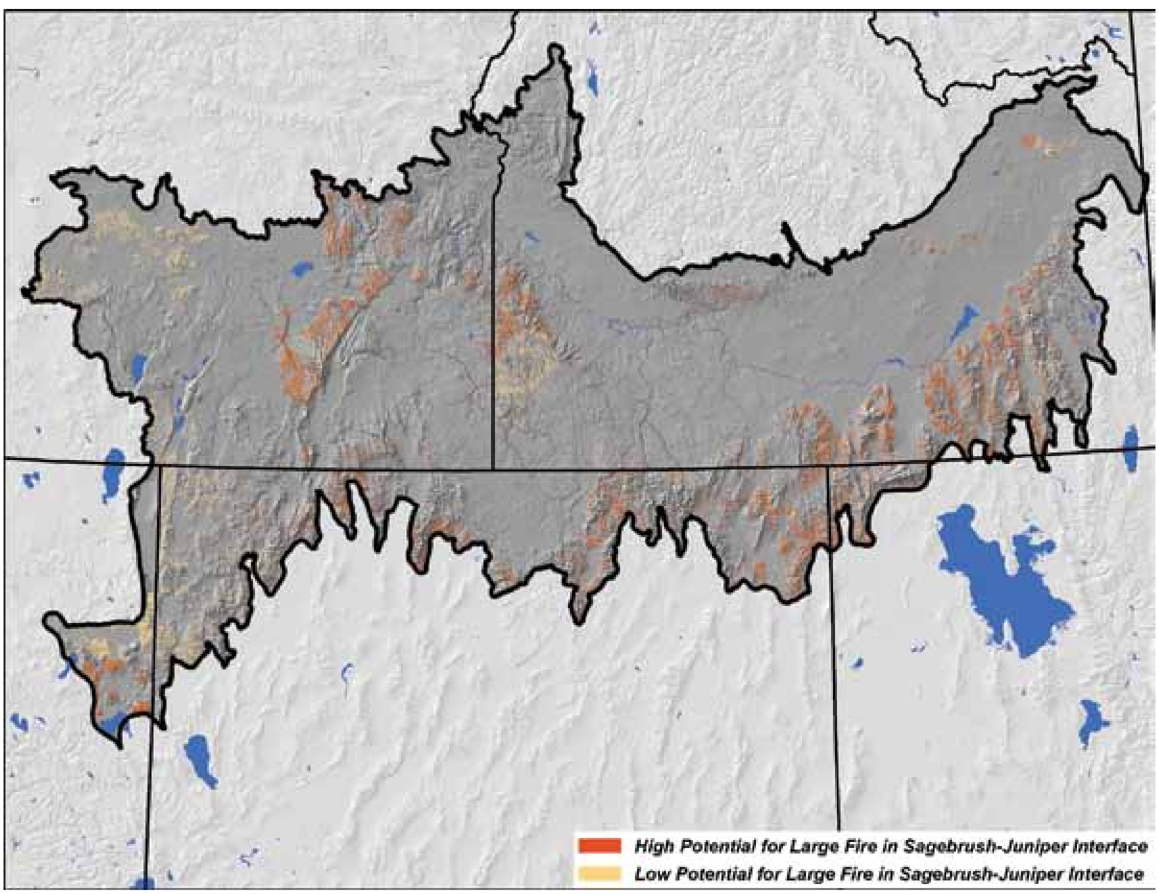

Figure 17. Potential for large fire in the sagebrush-juniper interface in the NGB.

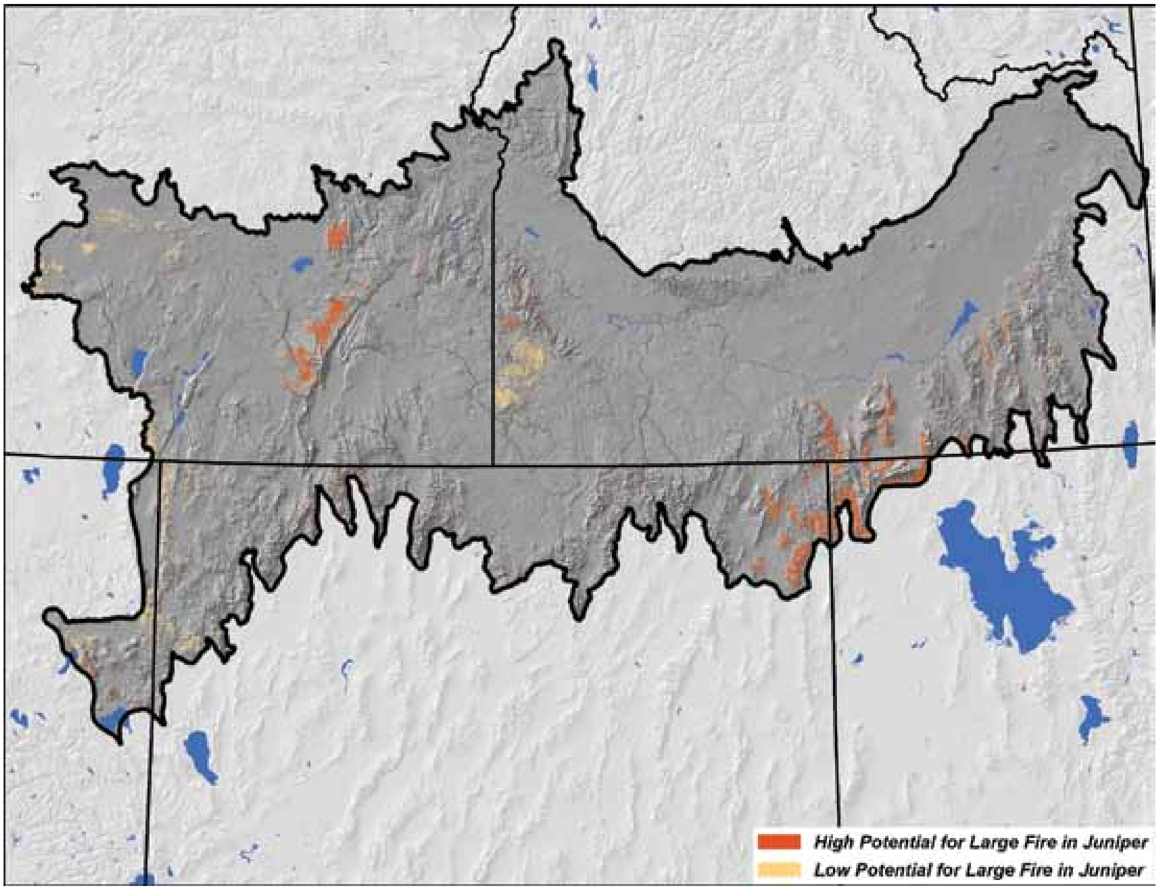

Figure 18. Potential for large fire in juniper in the NGB.

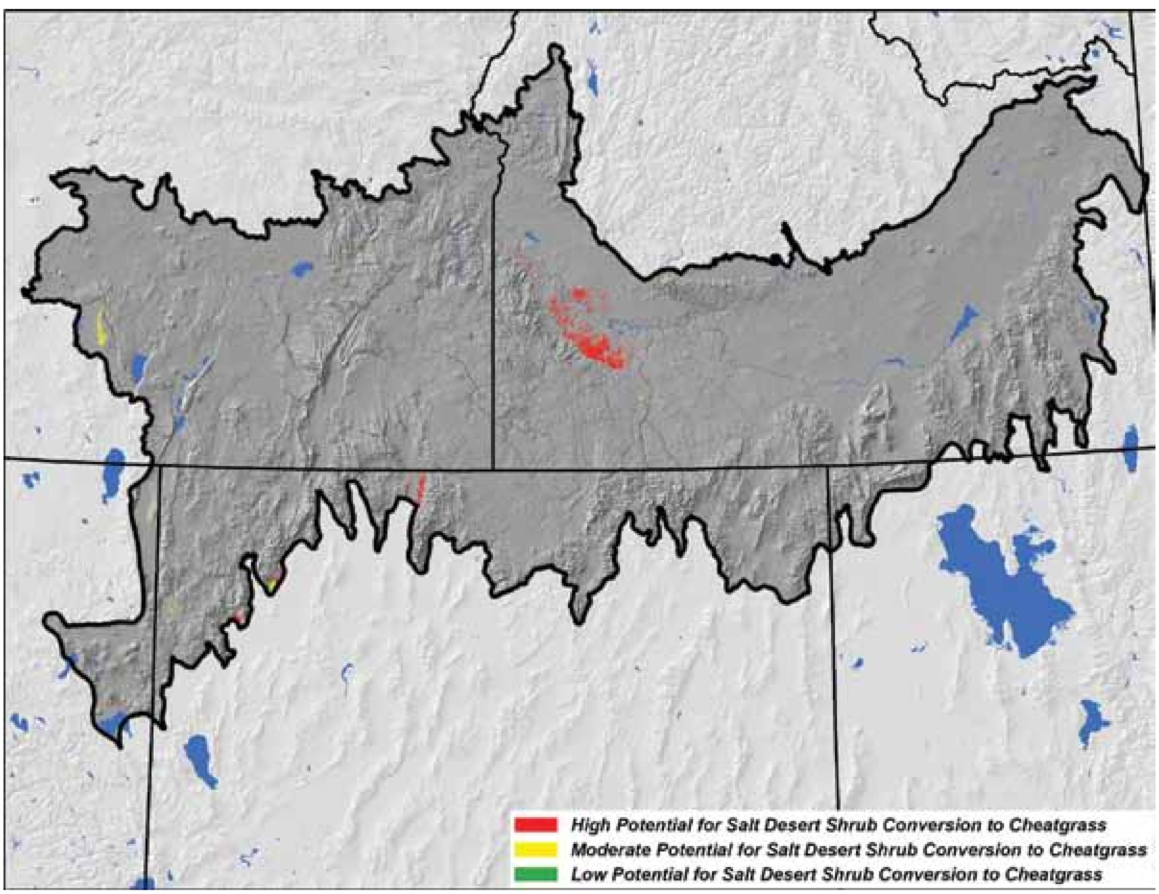

Figure 19. Potential for salt desert shrub conversion to cheatgrass in the NGB.

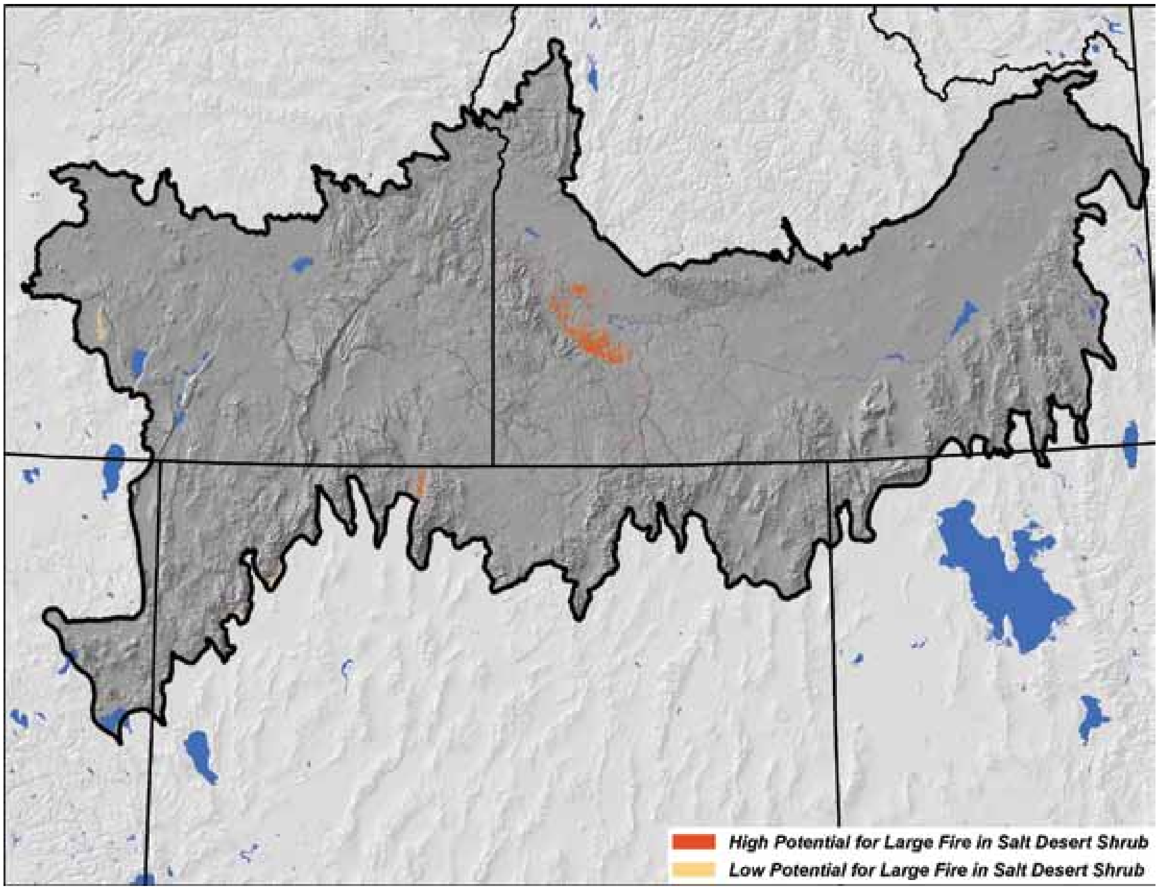

Figure 20. Potential for large fire in salt desert shrub in the NGB.

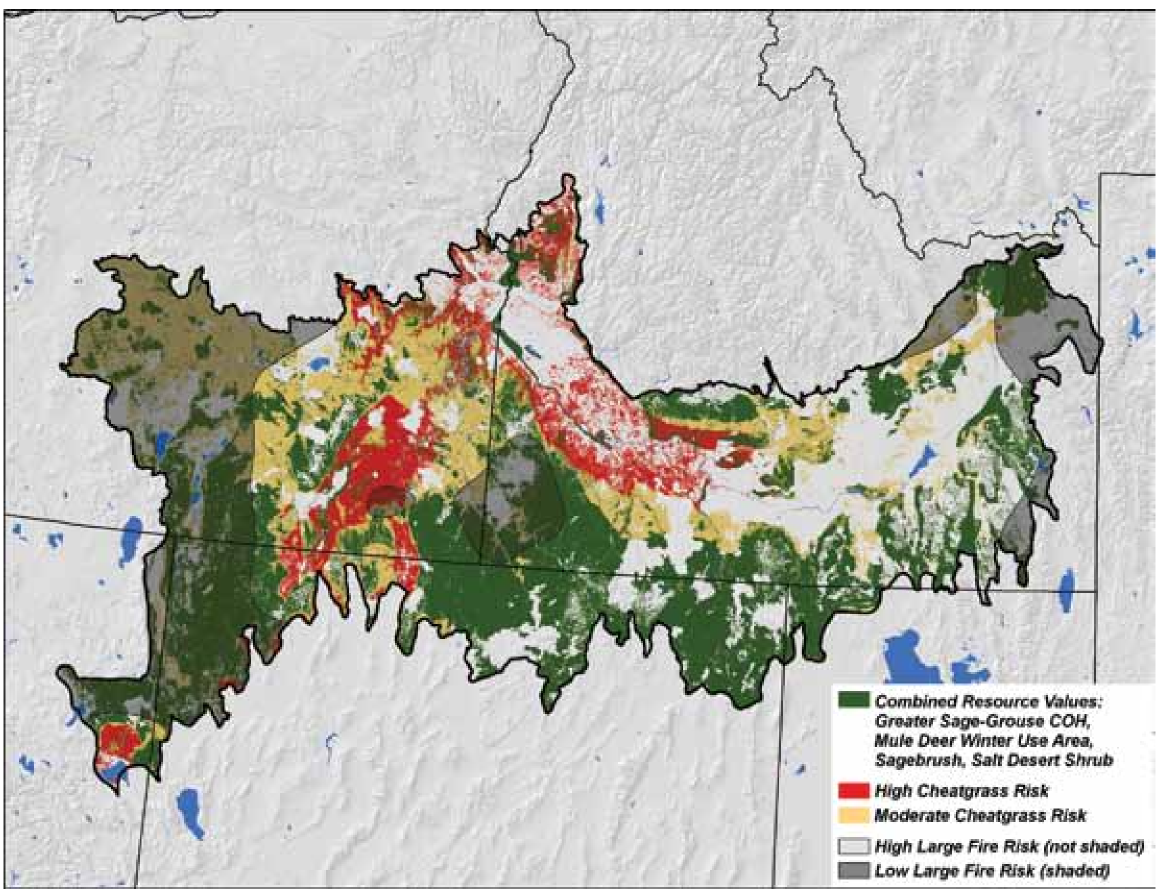

Figure 21. Potential for cheatgrass conversion and large fire in high resource value areas in the NGB.

Table 2. Management questions addressed.

Where are sagebrush areas with potential for change to cheatgrass after disturbance from fire?			
Variables	**Acres**	**% NGB**	**Map**
Sagebrush + high cheatgrass risk	3,859,623	8.0	Figure 10
Sagebrush + high fire risk	17,201,690	35.5	Figure 11
Sagebrush + high cheatgrass risk + high fire risk	3,710,118	7.7	
Where are greater sage-grouse currently occupied habitat (GRSG COH) areas with potential for change to cheatgrass after disturbance from fire?			
Variables	**Acres**	**% NGB**	**Map**
GRSG COH + high cheatgrass risk	2,086,154	4.3	Figure 12
GRSG COH + high fire risk	14,429,620	29.8	Figure 13
GRSG COH + high cheatgrass risk + high fire risk	1,950,291	4.0	
Where are mule deer winter use areas with potential for change to cheatgrass after disturbance from fire?			
Variables	**Acres**	**% NGB**	**Map**
Mule deer winter use + high cheatgrass risk	876,489	1.8	Figure 14
Mule deer winter use + high fire risk	6,085,306	12.6	Figure 15
Mule deer winter use + high cheatgrass risk + high fire risk	839,472	1.7	
Where are sagebrush-juniper interface areas with potential for change to cheatgrass after disturbance from fire?			
Variables	**Acres**	**% NGB**	**Map**
Sagebrush-juniper interface + high cheatgrass risk	46,183	0.1	Figure 16
Sagebrush-juniper interface + high fire risk	1,745,642	3.6	Figure 17
Sagebrush-juniper interface + high cheatgrass risk + high fire risk	44,818	0.1	
Where are juniper areas with little potential for change due to fire exclusion?			
Variables	**Acres**	**% NGB**	**Map**
Juniper + low fire risk	598,263	1.2	Figure 18
Where are salt desert shrub areas with potential for change to cheatgrass after disturbance from fire?			
Variables	**Acres**	**% NGB**	**Map**
Salt desert shrub + high cheatgrass risk	258,557	0.5	Figure 19
Salt desert shrub + high fire risk	241,611	0.5	Figure 20
Salt desert shrub + high cheatgrass risk + high fire risk	221,026	0.5	
Where are sagebrush-juniper interface areas with potential for change to juniper?			
Was not answered/data gap			
Where are greater sage-grouse currently occupied habitat areas in sagebrush-juniper interface areas with potential for change to juniper?			
Was not answered/data gap			

Table 3. Overlapping acreage of ecological values and change agents in the NGB.

Acres in NGB		High cheatgrass risk		High cheatgrass and high fire risk		Low fire risk	
		Acres	Percent	Acres	Percent	Acres	Percent
Sagebrush	24,024,881	3,859,623	16%	3,710,118	15%		
Greater sage-grouse COH	19,568,462	2,086,154	11%	1,950,291	10		
Mule deer winter habitat	6,475,002	876,489	14%	839,472	13%		
Sagebrush-juniper interface	2,734,664	46,183	2%	44,818	2%		
Juniper	1,452,431					598,263	41%
Salt desert shrub	329,974	258,577	78%	221,026	67%		
Northern Great Basin	48,390,000	4,167,456	9%	3,978,804	8%	12,730,131	26%

DISCUSSION

Our spatial risk assessment approach identified existing sagebrush, juniper, sagebrush-juniper interface, salt desert shrub, greater sage-grouse currently occupied habitat, and mule deer winter use areas of conservation value that would benefit from additional management intervention. Implementing local fire suppression, fire use, and nonfire use actions (e.g., treatments) within the framework of the regional strategies in areas of potential change from cheatgrass, wildfire, and lack of fire, could support achieving related regionwide goals.

Based on recommendations made by assessment stakeholders, the use of lightning strike data was examined to model large fire risk. We obtained all recorded archival lightning strike data from 1991 to 2008 from the National Interagency Fire Center (NIFC). A lightning strike density map was constructed and compared both to contoured large fire (greater than or equal to 1,000 acres) density and fire occurrence locations for fires greater than or equal to 300 acres. No significant correlation was found to exist between lightning strikes and large fires within the assessment area. Therefore, lightning strike data were not used in the analysis.

The subject of fire cause related to level of risk was also discussed. Fire occurrence data are attributed inconsistently with respect to human versus natural causes. Since many fires are not attributed, these data were considered to be of limited use to model building. A map of fire cause relative to highways is somewhat visually helpful in that it depicts the human factor as fires concentrated along roads where the fires are attributed. The assessment team discussed this and other anthropogenic disturbances and decided that these would be addressed primarily at the local level, not in this analysis.

A stakeholder requested adding ponderosa pine to enable assessing concern for ponderosa pine expansion into sagebrush. Ponderosa pine distribution was reviewed and there was very little occurrence of this plant community in the NGB so it has not been included in the analysis.

Removal of postimagery fire perimeters resulted in removal of a large acreage of sagebrush (1.9 million acres) and lesser juniper, sagebrush-juniper interface, and salt desert shrubs. While this was done due to limitations in the land cover data available, these areas are and have been the subject of substantial rehabilitation investments by BLM. Stakeholders indicated that they warrant high priority for wildfire suppression even though they are not represented by model outputs. Local resource and fire managers should consider this in fire planning decisions.

Uncertainty in information that contributes to management decisions can result in poor management actions (Carey et al. 2005). Uncertainty was minimized in the analysis of potential changes to plant communities and animal species of concern from the change agents by basing our assumptions on quantitative and qualitative information made available through the literature and expert opinion. Nevertheless, due to the current lack of information on the characteristics and spatial distribution of factors that affect the plant communities and animal species of concern in the NGB, this analysis still contains uncertainties that are difficult to quantify. As new information becomes available, this assessment can be improved by reevaluating assumptions and updating the spatial data themes. This information is likely to take many years to obtain.

Models created at one scale may perform poorly if applied at other scales (Wiens 1989). The spatial extent and resolution of the data used to conduct this analysis approximates the scale at which the results are to be used. The purpose of this assessment was to identify priority areas across moderate to broad regional settings at approximately a 1:100,000 or smaller scale. The purpose was not to locate site-specific locations for projects and other actions. Localized datasets of limited extent and high resolution were avoided to maintain regionwide consistency and homogenous representation of factors in the analysis. Conservatively, the resulting data are relatively coarse grained and are most

appropriately used over a moderate to broad geographic extent. It is unreasonable to expect a rapid analysis developed at a relatively coarse scale to accurately predict site-specific locations for on-the-ground actions (projects) on a local scale.

The inherent effect of pooling land cover data categories offsets uncertainties about spatial data accuracy. Overall, no single source or accumulation of uncertainty about land cover is so overpowering that it would prevent prospective use of the rapid analysis output in the moderate to broad regional setting to accomplish the purpose of this assessment.

Assumptions and Limitations

Application of the model is predicated upon understanding inherent uncertainties and limitations. Proper consideration of model assumptions is a key element of this understanding. The following model assumptions, limitations, and advisements must be taken into account by practitioners to support defensible application of the results:

1. The cheatgrass risk model requires extensive field evaluation to assess its performance. New research is needed to improve model projections of risk for use in management decisions. This new research is critical, given the rapid rate at which cheatgrass continues to invade and displace native shrublands, as is the need to accurately identify areas where management intervention would be most effective (Suring et al. 2005).

2. Amounts of specific cover types at risk from cheatgrass may be under- or overestimated because of uncertainties about the changing adaptability of cheatgrass (Suring et al. 2005).

3. Most areas occupied by the salt desert shrub cover type are assumed to be susceptible to cheatgrass displacement; however, this assumption may lead to overestimation of the area at risk (Suring et al. 2005).

4. Portions of other cover types associated with highly saline or other soil types that inhibit cheatgrass establishment may also have lower risk than was estimated (Rasmuson 1996; Suring et al. 2005).

5. The cheatgrass risk model is not intended to identify areas where cheatgrass has already displaced sagebrush and other susceptible cover types. Rather, the model was designed and applied to predict the risk of future displacement of existing native vegetation by cheatgrass within 30 years (Suring et al. 2005).

6. This regional level spatial assessment was designed to be conducted rapidly. As such, the specific methodology used does not take temporal variance (i.e., seasonality) into account.

7. Areas currently dominated by sagebrush land cover have sagebrush capability.

8. Areas currently dominated by sagebrush-juniper interface land cover have sagebrush capability and are present largely due to fire exclusion.

9. Areas currently dominated by juniper land cover generally have sagebrush capability and are present largely due to fire exclusion.

10. Areas currently dominated by salt desert shrub land cover have salt desert shrub capability.

11. Areas currently dominated by sagebrush, juniper, and sagebrush-juniper interface land cover must be examined in the field to evaluate local, site-specific capability relative to proposed projects. Field examination is needed to determine the likelihood of the project successfully achieving desired sagebrush or salt desert shrub plant community objectives while avoiding long-term dominance of cheatgrass as a result of the proposed project. The field examination should involve interdisciplinary use of local knowledge; soil survey, soil moisture, range

site, ecological site, wildlife habitat site, land use history, and other local information; and visual examination of vegetation in previously disturbed sites in the immediate vicinity (e.g., fire, surface disturbance). The field examination should be considered a requisite to fuel treatment, prescribed fire, and restoration treatment project funding and on-the-ground implementation.

12. Areas proximal to large wildfire are assumed to have greater relative likelihood of future large wildfire occurrence than other areas.

13. The sagebrush-juniper interface land cover category is assumed to adequately represent areas of juniper expansion (e.g., encroachment) in existing sagebrush plant communities.

14. All existing juniper land cover areas are assumed to have the sagebrush capability and are largely present due to the lack of fire. As such, management consideration for "old growth" juniper must occur locally.

15. Resource or fire managers, planners, and practitioners should not consider boundaries between priority areas suitable for assigning or zoning areas for fire suppression or greenstripping purposes.

16. Suggested regional-level goals presented here are for use within the context of this assessment. They are not necessarily representing, or consistent with, current USDI BLM land use planning activities or those activities of other entities in the NGB region.

17. There is a need to establish a change agent associated with wildfire focused on what would likely contribute to the greatest amount of sagebrush, greater sage-grouse currently occupied habitat, and mule deer winter use area loss in the future.

18. Practitioners are advised not to apply analysis results at a scale larger than 1:100,000 (i.e., priority areas are not a substitute for local, site-specific project planning, evaluation, and implementation) and the minimum mapping unit is approximately 40 acres.

19. Potential future implementation activities and other considerations (e.g., model assumptions) presented in this document are assumed to be an element of a comprehensive monitoring program in the region.

Regional to Local Level Ecoregional Direction and Implementation

During the ecoregional direction process, information from experts and stakeholders should be used to identify potential actions for use as the basis to formulate and design regional level strategies to ameliorate identified risk. The potential on-the-ground actions can be grouped into three categories: 1) wildfire suppression levels and actions, 2) treatments utilizing fire (e.g., prescribed fire), and 3) vegetation/fuel treatments not utilizing fire (e.g., greenstripping, fuel breaks, mechanical, chemical, seeding, other). For assessment purposes, generalized regionwide goals for the plant communities and animal species of concern can also be developed and may potentially include: 1) maintain or increase extent of existing sagebrush plant community; 2) minimize existing sagebrush plant community conversion to cheatgrass, juniper, and sagebrush-juniper interface; 3) maintain or increase extent of existing greater sage-grouse currently occupied habitat and existing mule deer winter use areas; 4) maintain extent of existing salt desert shrub plant community; and 5) minimize existing salt desert shrub conversion to cheatgrass. Ultimately, the potential actions could be integrated with local practitioner priorities relative to regional goals to form regional management strategies. The regional strategies could form a bridge or link between the status of resource values and potential for change and practitioner opportunities.

Conclusion

By using a spatial approach, this assessment identified priority areas within the NGB that may require further management attention. Greater sage-grouse habitat, mule deer habitat, sagebrush, and salt desert shrub plant community areas in portions of Nevada, Idaho,

Oregon, Utah, and California are at comparatively high risk from wildfire in arid areas conducive to cheatgrass invasion. Conversely, areas of juniper and juniper expansion that lack fire represent areas at risk. For management to be effective over this large geographic region, it is essential to successfully manage those areas where the resource values of concern are most vulnerable. It may be unreasonable to safeguard all greater sage-grouse habitat, mule deer winter use areas, sagebrush plant communities, and other resource values from change agents for the entire region, but management is more likely to be successful by maintaining and protecting resources of concern present in more arid areas. Similarly, it may be difficult to restore areas of juniper dominance and expansion in the entire region, but maintenance and restoration are more likely to be successful by applying specific fire management practices and restoration activities in areas where there is a relatively high likelihood of achieving success.

LITERATURE CITED

Adams, A.W. 1975. A brief history of juniper and shrub populations in southern Oregon. Final report on federal aid to wildlife restoration project U-70-R. Oregon State University, Corvallis, Oregon, U.S.A. 33 pp.

Betancourt, J.L. 1987. Paleoecology of pinyon-juniper wood-lands: summary. Pages 129-139 *in* R.L. Everett, compiler. Proceedings: Pinyon-Juniper Conference. General Technical Report, INT-215. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, U.S.A.

Billings, W.D. 1990. *Bromus tectorum*, a biotic cause of ecosystem impoverishment in the Great Basin. Pages 301-322 *in* G.M. Woodwell, editor. Patterns and processes of biotic impoverishment. Cambridge University Press, New York, New York, U.S.A.

Brooks, M.L. 1999. Alien annual grasses and fire in the Mojave Desert. Madroño 46:13-19.

Brooks, M.L. and D.A. Pyke. 2001. Invasive plants and fire in the deserts of North America. Pages 1–14 *in* K.E.M. Galley and T.P. Wilson, editors. Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species. Fire Conferece 2000: The First National Congress on Fire Ecology, Prevention, and Management. Misc. Publication No. 11, Tall Timbers Research Station, Tallahassee, Florida, U.S.A.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobb, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. BioScience 54: 677-688.

Bryce, S.A., A.J. Woods, J.D. Morefield, J.M. Omernik, T.R. McKay, G.K. Brackley, R.K. Hall, D.K. Higgins, D.C. McMorran, K.E. Vargas, E.B. Petersen, D.C. Zamudio, and J.A.Comstock. 2003. Ecoregions of Nevada (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,350,000).

Burkhardt, J.W. and E.W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology 76:472-484.

Carey, J., M. Burgman, C. Miller, and Y. En Chee. 2005. An implication of qualitative risk assessment in park management. Australasian Journal of Environmental Management 12:6-15.

Chambers, J.C. 2000. Seed movements and seedling fates in disturbed sagebrush steppe ecosystems: Implications for restoration. Ecological Applications 5:1400-1413.

Chambers, J.C. 2001. *Pinus monophylla* establishment in an expanding piñon-juniper woodland: environmental conditions, facilitation, and interacting factors. Journal of Vegetation Science 12:27-40.

Chambers, J.C., and A.R. Linnerooth. 2001. Restoring riparian corridors dominated by *Artemisia* using alternative state and threshold concepts: Environmental and seedling establishment response. Applied Vegetation Science 4:157-166.

Chambers, J.C., B.A. Roundy, R.R. Blank, S.E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum?* Ecological Monographs 77:117-145.

Comer, P., D. Faber-Langendoen, and R. Evans. 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe. Arlington, Virginia, U.S.A. 75 pp.

Commission for Environmental Cooperation. 2006. North American environmental atlas – Level III terrestrial ecoregions. Created on November 24, 2009, by the Commission for Environmental Cooperation. Available at: *http://www.cec.org/atlas/files/Terrestrial_Ecoregions_L3/TerrestrialEcoregions_L3_GeoPDF.zip* Accessed December 2009.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. Wildlife Society Bulletin 28:967-985.

Connelly, J.W., S.T. Knick, M.A. Schroeder, S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies, Cheyenne, Wyoming, U.S.A.

Cottam, W.P. and G. Stewart. 1940. Plant succession as a result of grazing and of meadow desiccation by erosion since settlement in 1892. Journal of Forestry 38:613-626.

D'Antonio, C.M., and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23: 63-87.

Daubenmire, R. 1970. Steppe vegetation of Washington. Washington Agricultural Experiment Station Technical Bulletin 62:1-131.

Emmerich, F.L., F.H. Tipton, and J.A. Young. 1993. Cheatgrass: Changing perspectives and management strategies. Rangelands 15:37-40.

Federal Register. 2004. Endangered and threatened wildlife and plants; 90-day finding for petitions to list the greater sage-grouse as threatened or endangered: notice. Federal Register 69:21484-21494.

Federal Register. 2005. Endangered and threatened wildlife and plants; 12-month finding for petitions to list the greater sage-grouse as threatened or endangered: proposed rule. Federal Register 70:2244-2282.

Gedney, D.R., D.L. Azuma, C.L. Bolsinger, and N. McKay. 1999. Western juniper in eastern Oregon. General Technical Report PNW-464. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 53 pp.

Grech, A. and H. Marsh. 2008. Rapid ecoregional assessment of risks to a mobile marine mammal in an ecosystem-scale marine protected area. Conservation Biology 22:711-720.

Heyerdahl, E.K., R.F. Miller, R.A. Parsons. 2006. History of fire and Douglas-fir establishment in a savanna and sagebrush-grassland mosaic, southwestern Montana, USA. Forest Ecology and Management 230:107-118.

Homer, C., C. Huang, L. Yang, B. Wylie, and M. Coan. 2004. Development of a 2001 national landcover database for the United States. Photogrammetric Engineering and Remote Sensing 70:829-840.

Humphrey, L.D. and E.W. Schupp. 2004. Competition as a barrier to establishment of a native perennial grass (*Elymus elymoides*) in alien annual grass (*Bromus tectorum*) communities. Journal of Arid Environments 58:405–422.

Kagen, J.S., J.L. Ohmann, M. Gregory, and C. Tobalske. 2008. Land Cover Map for Map Zones 8 and 9 Developed from SageMap, GNN, and SWReGAP: A Pilot for NWGAP. GAP Analysis Bulletin 15:1-19.

Knapp, P.A. 1996. Cheatgrass (*Bromus tectorum* L) dominance in the Great Basin Desert: History, persistence, and influences to human activities. Global Environmental Change 6:37-52.

Knapp, P.A. 1998. Spatio-temporal patterns of large grassland fires in the Intermountain West, U.S.A. Global Ecology and Biogeography Letters 7: 259-273.

Kucera, T.E. and K.E. Mayer. 1999. A sportsman's guide to improving deer habitat in California. State of California, The Resources Agency, Department of Fish and Game, Sacramento, California. 95 pp.

Lysne, C.R. and M. Pellant. 2004. Establishment of aerially seeded big sagebrush following southern Idaho fires. Technical Bulletin 2004-01. U.S. Department of the Interior, Bureau of Land Management, Idaho State Office, Boise, ID, U.S.A.

Mack, R.N. 1986. Alien plant invasion into the Intermountain West: A case history. Pages 191-210 *in* H.A. Mooney and J.A. Drake, editors. Ecology of biological invasions of North America and Hawaii. Ecological Studies 58. Springer-Verlag, New York, New York, U.S.A.

McGrath C.L., A.J. Woods, J.M. Omernik, S.A. Bryce, M. Edmondson, J.A. Nesser, J. Shelden, R.C. Crawford, J.A. Comstock, and M.D. Plocher. 2002. Ecoregions of Idaho (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,350,000).

Miller, R.F. and J.A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. Great Basin Naturalist 55:37–45.

Miller, R., T. Svejcar, and J. Rose. 1999. Conversion of shrub steppe to juniper woodland. Pages 385-390 *in* S.B. Monsen and R. Stevens, compilers. Proceedings: ecology and management of pinyon-juniper communities within the interior west. Proceedings RMRS-P-9. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, U.S.A.

Miller, R., T. Svejcar, and J. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53:574–585.

Miller, R.F. and R.J. Tausch. 2001. The role of fire in pinyon and juniper woodlands: A descriptive analysis. Pages 15-30 in K.E.M. Galley and T.P. Wilson, editors. Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species. Tall Timbers Research Station, Miscellaneous Publication 11. Tallahassee, Florida, U.S.A.

Miller, R.F., J.D. Bates, and T.J. Svejcar. 2005. Biology, ecology, and management of western juniper. Technical Bulletin 152. Oregon State University, Agricultural Experiment Station, Corvallis, Oregon, U.S.A. 77 pp.

Miller, R.F., R.J. Tausch, and E.D. McArthur. 2008. Age structure and expansion of piñon-juniper woodlands: A regional perspective in the Intermountain West. Research Paper Report RMRS-RP-69. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, U.S.A. 15 pp.

Mosely, J.C., S.C. Bunting, M.E. Manoukian. 1999. Cheatgrass. Pages 175-188 *in* R.L. Sheley, and J.K. Petroff, editors. Biology and management of noxious rangeland weeds. Oregon State University Press. Corvallis, Oregon, U.S.A.

Pellant, M. and L. Reichert. 1984. Management and rehabilitation of a burned winterfat community in southwestern Idaho. Pages 281-285 *in* A.R. Tiedemann, E.D. McArthur, and H.C. Stutz, C. Howard, compilers. Proceedings—Symposium on the biology of *Atriplex* and related chenopods. General Technical Report INT-172. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station Ogden, Utah, U.S.A.

Prior-Magee, J.S., K.G. Boykin, D.F. Bradford, W.G. Kepner, J.H. Lowry, D.L. Schrupp, K.A. Thomas, and B.C. Thompson, editors. 2007. Southwest regional gap analysis project final report. USGS Gap Analysis Program, Moscow, Idaho, U.S.A.

Pull, H., and J. Dunning. 1995. Spatially explicit population models. Ecological Applications 15:2.

Rasmuson, K.E. 1996. Population and individual responses of *Bromus tectorum* to environmental stresses: A study of factors that may limit its distribution in cold desert habitats. Ph.D. Dissertation, Idaho State University, Pocatello, Idaho.

Secretariat of the Convention on Biological Diversity. 2006. Guidelines for the rapid ecological assessment of biodiversity in inland water, coastal and marine areas. Convention on Biological Diversity Technical Series No. 22, Montreal, Canada.

Stiver, S.J., A.D. Apa, J.R. Bohne, S.D. Bunnell, P.A. Deibert, S.C. Gardner, M.A. Hilliard, C.W. McCarthy, and M.A. Schroeder. 2006. Greater sage-grouse comprehensive conservation strategy. Western Association of Fish and Wildlife Agencies. *Unpublished Report*. Cheyenne, WY, U.S.A.

Suring, L.H., M.J. Wisdom, R.J. Tausch, R.F. Miller, M.M. Rowland, L. Schueck, and C.W. Meinke. 2005. Modeling threats to sagebrush and other shrubland communities. Chapter 4 in Part II: Regional assessment of habitats for species of conservation concern in the Great Basin. Pages 114-149 *in* M.J. Wisdom, M.M. Rowland, and L.H. Suring, editors. Habitat threats in the sagebrush ecosystem: Methods of regional assessment and applications in the Great Basin. Alliance Communications Group, Lawrence, KS, U.S.A.

Tausch, R.J. 1999. Historic pinyon and juniper woodland development. Pages 12-19 *in*: S.B. Monsen and R. Stevens, compilers. Proceedings: Ecology and management of pinyon-juniper communities within the interior west. Proceedings RMRS-P-9 U.S. Department of

Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, U.S.A.

Tausch, R.J., N.E. West, and A.A. Nabi. 1981. Tree age and dominance patterns in Great Basin pinyon-juniper woodlands. Journal of Range Management 4:259-264.

Tausch, R.J., and N.E. West. 1988. Differential establishment of pinyon and juniper following fire. The American Midland Naturalist 119:174-184.

Tausch, R.J.and N.E. West. 1995. Plant species composition patterns with differences in tree dominance on a southwestern Utah piñon-juniper site. Pages 16-23 *in* D.W. Shaw, E.F. Aldon, and C. LoSapio, technical coordinators. Desired future conditions for piñon-juniper ecosystems: Proceedings of the symposium, 1994 August 8-12, Flagstaff, AZ. General Technical Report RM-258. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, U.S.A.

Theobald, D. 2003. Targeting conservation action through assessment of protection and exurban threats. Conservation Biology 17:1624-1637.

Thorson, T.D., S.A. Bryce, D.A. Lammers, A.J. Woods, J.M. Omernik, J. Kagan, D.E. Pater, and J.A.Comstock. 2003. Ecoregions of Oregon (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

USDI – USGS. 2005. Current distribution of sagebrush and associated vegetation in the Columbia Basin and southwestern regions [ShrubMap]. U.S. Department of the Interior, U.S. Geological Survey. Available online at *http://sagemap.wr.usgs.gov/ShrubMap_home.htm*. Accessed January 2009.

USDI – USGS. 2007. The national map LANDFIRE: LANDFIRE national existing vegetation type layer. U.S. Department of the Interior, U.S. Geological Survey. Available online at: *http://gisdata.usgs.net/website/landfire/*. Accessed July 2009.

West, N.E. 1983. Intermountain salt-desert shrubland. Pages 375-397 *in*: N.E. West, editor. Temperate deserts and semi-deserts. Volume 5 *from* D. Goodall, editor in chief. Ecosystems of the world. Elsevier Scientific Publishing Company, New York, New York, U.S.A.

West, N.E. 1994. Effects of fire on salt-desert shrub rangelands. Pages 71-74 *in* S.B. Monsen, and S.G. Kitchen, compilers. Proceedings- Ecology and management of annual rangelands, Boise, Idaho, U.S.A. General Technical Report INT-GTR-313. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, U.S.A.

West, N.E. and N.S. Van Pelt. 1986. Successional patterns in pinyon-juniper woodlands. Pages 43-52 *in* R.L. Everett, editor. Proceedings - Pinyon-juniper conference. GeneralTechnical Report INT-215. U.S. Department of Agriculture, Forest Service Intermountain Research Station, Ogden, UT, U.S.A.

Whisenant, S.G. 1990. Postfire population dynamics of *Bromus japonicus*. American Midland Naturalist 123:301-308.

Wiens, J.A. 1989. Spatial scaling in ecology. Functional Ecology 3:385-397.

Wisdom, M.J., M.M. Rowland, and L.H. Suring, editors. 2005. Habitat threats in the sagebrush ecosystem: Methods of regional assessment and applications in the Great Basin. Alliance Communications Group, Lawrence, Kansas, U.S.A.

Woods, A.J., D.A.Lammers, S.A., Bryce, J.M. Omernik, R.L. Denton, M. Domeier, and J.A. Comstock. 2001. Ecoregions of Utah (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,175,000).

APPENDICES

Appendix 1. NGB Rapid Ecoregional Assessment Model Data Sources

Land Cover/ Land Use Dataset	Source	Cell Size	Pub. Year	Year Imagery Acquired
Regional Land Cover Datasets				
Southwest Regional GAP	RS/GIS Laboratory, College of Natural Resources, USU	30 m	2005	1999–2001
Northwest GAP	Northwest Gap Analysis Project: USGS GAP Analysis Program	30 m	2009	1999–2001
LANDFIRE	U.S. Department of the Interior, USGS	30 m	07/08	2007
Regional Datasets				
Wildfire Perimeters	GeoMAC, GeoMAC/USGS, and BLM field offices	shapefiles	2008	NA
Fire Occurrence 1991–2007	U.S. Bureau of Land Management NOC	shapefile	2008	NA
Cheatgrass Risk Model	Adapted (by NOC) from Wisdom et al. 2005	30 m	2009	NA
Animal Species of Concern				
GRSG Currently Occupied Habitat	U.S. Bureau of Land Management NOC-DRS-OC570	30 m	2009	NA
Mule Deer Winter Use Areas	RS/GIS Laboratory, Utah State University; BLM-NOC	30 m	2004	NA
Ancillary Data				
CEC Level III Ecoregions	U.S. Environmental Protection Agency	coverage	2003	NA
National Elevation Dataset (NED)	USGS, EROS Data Center	30 m	1999	NA

Appendix 2. Land Cover Sources for Plant Communities of Concern

Object ID	NW GAP Description	SW GAP Description	Landfire EVT Description	NGB Model Description	Category
2072			Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	1
1048		Inter-Mountain Basins Big Sagebrush Shrubland		Inter-Mountain Basins Big Sagebrush Shrubland	1
1049		Great Basin Xeric Mixed Sagebrush Shrubland		Great Basin Xeric Mixed Sagebrush Shrubland	1
1050		Colorado Plateau Mixed Low Sagebrush Shrubland		Colorado Plateau Mixed Low Sagebrush Shrubland	1
1062		Inter-Mountain Basins Montane Sagebrush Steppe		Inter-Mountain Basins Montane Sagebrush Steppe	1
1066		Inter-Mountain Basins Big Sagebrush Steppe		Inter-Mountain Basins Big Sagebrush Steppe	1
1104		Wyoming Basins Low Sagebrush Shrubland		Wyoming Basins Low Sagebrush Shrubland	1
2062			Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	1
2064			Colorado Plateau Mixed Low Sagebrush Shrubland	Colorado Plateau Mixed Low Sagebrush Shrubland	1
2065			Columbia Plateau Scabland Shrubland	Columbia Plateau Scabland Shrubland	1
9321	Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe			Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe	1
2079			Great Basin Xeric Mixed Sagebrush Shrubland	Great Basin Xeric Mixed Sagebrush Shrubland	1
2080			Inter-Mountain Basins Big Sagebrush Shrubland	Inter-Mountain Basins Big Sagebrush Shrubland	1
2124			Columbia Plateau Low Sagebrush Steppe	Columbia Plateau Low Sagebrush Steppe	1
2125			Inter-Mountain Basins Big Sagebrush Steppe	Inter-Mountain Basins Big Sagebrush Steppe	1
5202	Columbia Plateau Scabland Shrubland			Columbia Plateau Scabland Shrubland	1
2220			Artemisia tridentata ssp. vaseyana Shrubland Alliance	Artemisia tridentata ssp. vaseyana Shrubland Alliance	1

Appendix 2. Land Cover Sources for Plant Communities of Concern (continued).

Object ID	NW GAP Description	SW GAP Description	Landfire EVT Description	NGB Model Description	Category
5256	Great Basin Xeric Mixed Sagebrush Shrubland			Great Basin Xeric Mixed Sagebrush Shrubland	1
5455	Inter-Mountain Basins Montane Sagebrush Steppe			Inter-Mountain Basins Montane Sagebrush Steppe	1
5454	Inter-Mountain Basins Big Sagebrush Steppe			Inter-Mountain Basins Big Sagebrush Steppe	1
5453	Columbia Plateau Low Sagebrush Steppe			Columbia Plateau Low Sagebrush Steppe	1
5257	Inter-Mountain Basins Big Sagebrush Shrubland			Inter-Mountain Basins Big Sagebrush Shrubland	1
5209	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe			Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	1
2126			Inter-Mountain Basins Montane Sagebrush Steppe	Inter-Mountain Basins Montane Sagebrush Steppe	1
2017			Columbia Plateau Western Juniper Woodland and Savanna	Columbia Plateau Western Juniper Woodland and Savanna	2
1095		Madrean Juniper Savanna		Madrean Juniper Savanna	2
1092		Madrean Pinyon-Juniper Woodland		Madrean Pinyon-Juniper Woodland	2
1064		Inter-Mountain Basins Juniper Savanna		Inter-Mountain Basins Juniper Savanna	2
5404	Inter-Mountain Basins Juniper Savanna			Inter-Mountain Basins Juniper Savanna	2
1046		Colorado Plateau Pinyon-Juniper Shru-bland		Colorado Plateau Pinyon-Juniper Shrubland	2
1037		Great Basin Pinyon-Juniper Woodland		Great Basin Pinyon-Juniper Woodland	2
1036		Colorado Plateau Pinyon-Juniper Woodland		Colorado Plateau Pinyon-Juniper Woodland	2
1063		Southern Rocky Mountain Juniper Woodland and Savanna		Southern Rocky Mountain Juniper Woodland and Savanna	2
4206	Great Basin Pinyon-Juniper Woodland			Great Basin Pinyon-Juniper Woodland	2
2025			Madrean Pinyon-Juniper Woodland	Madrean Pinyon-Juniper Woodland	2
2119			Southern Rocky Mountain Juniper Woodland and Savanna	Southern Rocky Mountain Juniper Woodland and Savanna	2

Appendix 2. Land Cover Sources for Plant Communities of Concern (continued).

Object ID	NW GAP Description	SW GAP Description	Landfire EVT Description	NGB Model Description	Category
2116			Madrean Juniper Savanna	Madrean Juniper Savanna	2
2059			Southern Rocky Mountain Pinyon-Juniper Woodland	Southern Rocky Mountain Pinyon-Juniper Woodland	2
1035		Southern Rocky Mountain Pinyon-Juniper Woodland		Southern Rocky Mountain Pinyon-Juniper Woodland	2
2115			Inter-Mountain Basins Juniper Savanna	Inter-Mountain Basins Juniper Savanna	2
2019			Great Basin Pinyon-Juniper Woodland	Great Basin Pinyon-Juniper Woodland	2
2016			Colorado Plateau Pinyon-Juniper Woodland	Colorado Plateau Pinyon-Juniper Woodland	2
4204	Columbia Plateau Western Juniper Woodland and Savanna			Columbia Plateau Western Juniper Woodland and Savanna	2
1040		Inter-Mountain Basins Mat Saltbush Shrubland		Inter-Mountain Basins Mat Saltbush Shru-bland	4
2088			Sonora-Mojave Mixed Salt Desert Scrub	Sonora-Mojave Mixed Salt Desert Scrub	4
2081			Inter-Mountain Basins Mixed Salt Desert Scrub	Inter-Mountain Basins Mixed Salt Desert Scrub	4
1061		Sonora-Mojave Mixed Salt Desert Scrub		Sonora-Mojave Mixed Salt Desert Scrub	4
2075			Chihuahuan Mixed Salt Desert Scrub	Chihuahuan Mixed Salt Desert Scrub	4
5203	Inter-Mountain Basins Mat Saltbush Shrubland			Inter-Mountain Basins Mat Saltbush Shru-bland	4
5258	Inter-Mountain Basins Mixed Salt Desert Scrub			Inter-Mountain Basins Mixed Salt Desert Scrub	4
1096		Chihuahuan Mixed Salt Desert Scrub		Chihuahuan Mixed Salt Desert Scrub	4
2066			Inter-Mountain Basins Mat Saltbush Shrubland	Inter-Mountain Basins Mat Saltbush Shru-bland	4
1058		Inter-Mountain Basins Mixed Salt Desert Scrub		Inter-Mountain Basins Mixed Salt Desert Scrub	4

Appendix 3. Data Combinations for All Raw Data Used in the Assessment Model

Plant and Animal Values	Greater Sage-Grouse Currently Occupied Habitat (GRSG COH)	Mule Deer Winter Use (WU)	Change Agent Description	Acres
Juniper Group - -			High Cheatgrass Risk - High Large Fire Risk	1,192
Juniper Group - -			Low Cheatgrass Risk - Low Large Fire Risk	297,747
Juniper Group - -			Mod Cheatgrass Risk - High Large Fire Risk	34,171
Juniper Group - -			Low Cheatgrass Risk - High Large Fire Risk	359,607
Juniper Group - -			Mod Cheatgrass Risk - Low Large Fire Risk	15,466
Juniper Group - -			High Cheatgrass Risk - Low Large Fire Risk	130
Juniper Group - - MD_WU		MD_WU	High Cheatgrass Risk - High Large Fire Risk	879
Juniper Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	89,349
Juniper Group - - MD_WU		MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	46,424
Juniper Group - - MD_WU		MD_WU	High Cheatgrass Risk - Low Large Fire Risk	67
Juniper Group - - MD_WU		MD_WU	Low Cheatgrass Risk - High Large Fire Risk	293,361
Juniper Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	34,800
Juniper Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - Low Large Fire Risk	117,205
Juniper Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - High Large Fire Risk	12,080
Juniper Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - High Large Fire Risk	640
Juniper Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - High Large Fire Risk	72,155
Juniper Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - Low Large Fire Risk	5,448
Juniper Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - Low Large Fire Risk	25
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	14,865
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	11,528
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	6,555
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - High Large Fire Risk	131
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - High Large Fire Risk	38,598
Juniper Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - Low Large Fire Risk	9
Other Land Cover - -			Not in PCC - High Large Fire Risk	9,486,685
Other Land Cover - -			Not in PCC - Low Large Fire Risk	3,016,845
Other Land Cover - - MD_WU		MD_WU	Not in PCC - High Large Fire Risk	1,458,157
Other Land Cover - - MD_WU		MD_WU	Not in PCC - Low Large Fire Risk	411,594
Other Land Cover - GRSG_COH -	GRSG_COH		Not in PCC - High Large Fire Risk	1,243,493
Other Land Cover - GRSG_COH -	GRSG_COH		Not in PCC - Low Large Fire Risk	658,341
Other Land Cover - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Not in PCC - High Large Fire Risk	283,552
Other Land Cover - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Not in PCC - Low Large Fire Risk	144,509
Sagebrush Group - -			High Cheatgrass Risk - High Large Fire Risk	1,433,525
Sagebrush Group - -			Mod Cheatgrass Risk - High Large Fire Risk	1,382,494
Sagebrush Group - -			Low Cheatgrass Risk - High Large Fire Risk	1,536,912
Sagebrush Group - -			Low Cheatgrass Risk - Low Large Fire Risk	437,463

Appendix 3. Data Combinations for All Raw Data Used in the Assessment Model (continued).

Plant and Animal Values	Greater Sage-Grouse Currently Occupied Habitat (GRSG COH)	Mule Deer Winter Use (WU)	Change Agent Description	Acres
Sagebrush Group - -			Mod Cheatgrass Risk - Low Large Fire Risk	325,419
Sagebrush Group - -			High Cheatgrass Risk - Low Large Fire Risk	14,087
Sagebrush Group - - MD_WU		MD_WU	High Cheatgrass Risk - High Large Fire Risk	353,094
Sagebrush Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	490,489
Sagebrush Group - - MD_WU		MD_WU	Low Cheatgrass Risk - High Large Fire Risk	350,120
Sagebrush Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	191,424
Sagebrush Group - - MD_WU		MD_WU	High Cheatgrass Risk - Low Large Fire Risk	2,521
Sagebrush Group - - MD_WU		MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	53,077
Sagebrush Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - High Large Fire Risk	1,477,418
Sagebrush Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - High Large Fire Risk	2,632,522
Sagebrush Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - High Large Fire Risk	5,391,257
Sagebrush Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - Low Large Fire Risk	3,147,918
Sagebrush Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - Low Large Fire Risk	1,142,077
Sagebrush Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - Low Large Fire Risk	103,731
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	767,456
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - High Large Fire Risk	446,081
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - High Large Fire Risk	940,322
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	1,110,144
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	266,166
Sagebrush Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - Low Large Fire Risk	29,166
Sage-Juniper Interface Group - -			High Cheatgrass Risk - High Large Fire Risk	14,653
Sage-Juniper Interface Group - -			Mod Cheatgrass Risk - High Large Fire Risk	54,399
Sage-Juniper Interface Group - -			Low Cheatgrass Risk - Low Large Fire Risk	176,326
Sage-Juniper Interface Group - -			Low Cheatgrass Risk - High Large Fire Risk	343,419
Sage-Juniper Interface Group - -			Mod Cheatgrass Risk - Low Large Fire Risk	17,504
Sage-Juniper Interface Group - -			High Cheatgrass Risk - Low Large Fire Risk	435
Sage-Juniper Interface Group - - MD_WU		MD_WU	High Cheatgrass Risk - High Large Fire Risk	9,103
Sage-Juniper Interface Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	62,283
Sage-Juniper Interface Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	33,859
Sage-Juniper Interface Group - - MD_WU		MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	28,206
Sage-Juniper Interface Group - - MD_WU		MD_WU	High Cheatgrass Risk - Low Large Fire Risk	206
Sage-Juniper Interface Group - - MD_WU		MD_WU	Low Cheatgrass Risk - High Large Fire Risk	183,704
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - High Large Fire Risk	12,754
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - Low Large Fire Risk	450,916
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - Low Large Fire Risk	35,764

Appendix 3. Data Combinations for All Raw Data Used in the Assessment Model (continued).

Plant and Animal Values	Greater Sage-Grouse Currently Occupied Habitat (GRSG COH)	Mule Deer Winter Use (WU)	Change Agent Description	Acres
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - High Large Fire Risk	605,559
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - High Large Fire Risk	120,535
Sage-Juniper Interface Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - Low Large Fire Risk	363
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	132,845
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	83,813
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - Low Large Fire Risk	361
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - High Large Fire Risk	289,138
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	70,211
Sage-Juniper Interface Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - High Large Fire Risk	8,308
Salt Desert Shrub Group - -			High Cheatgrass Risk - High Large Fire Risk	195,175
Salt Desert Shrub Group - -			Mod Cheatgrass Risk - High Large Fire Risk	4,826
Salt Desert Shrub Group - -			Low Cheatgrass Risk - Low Large Fire Risk	3,458
Salt Desert Shrub Group - -			Mod Cheatgrass Risk - Low Large Fire Risk	33,650
Salt Desert Shrub Group - -			Low Cheatgrass Risk - High Large Fire Risk	5,901
Salt Desert Shrub Group - -			High Cheatgrass Risk - Low Large Fire Risk	31,139
Salt Desert Shrub Group - - MD_WU		MD_WU	High Cheatgrass Risk - High Large Fire Risk	20,892
Salt Desert Shrub Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	2,236
Salt Desert Shrub Group - - MD_WU		MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	2,633
Salt Desert Shrub Group - - MD_WU		MD_WU	High Cheatgrass Risk - Low Large Fire Risk	4,204
Salt Desert Shrub Group - - MD_WU		MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	129
Salt Desert Shrub Group - - MD_WU		MD_WU	Low Cheatgrass Risk - High Large Fire Risk	1,329
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - High Large Fire Risk	3,975
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - High Large Fire Risk	2,322
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - High Large Fire Risk	2,024
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		Mod Cheatgrass Risk - Low Large Fire Risk	4,617
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		Low Cheatgrass Risk - Low Large Fire Risk	4,822
Salt Desert Shrub Group - GRSG_COH -	GRSG_COH		High Cheatgrass Risk - Low Large Fire Risk	1,725
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - High Large Fire Risk	984
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - Low Large Fire Risk	1,854

Appendix 3. Data Combinations for All Raw Data Used in the Assessment Model (continued).

Plant and Animal Values	Greater Sage-Grouse Currently Occupied Habitat (GRSG COH)	Mule Deer Winter Use (WU)	Change Agent Description	Acres
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Mod Cheatgrass Risk - High Large Fire Risk	1,106
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	High Cheatgrass Risk - Low Large Fire Risk	483
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - Low Large Fire Risk	47
Salt Desert Shrub Group - GRSG_COH - MD_WU	GRSG_COH	MD_WU	Low Cheatgrass Risk - High Large Fire Risk	444

Appendix 4. Land Cover Data Quality Report

Prepared by Matt Bobo, BLM-NOC

There are five primary land cover datasets available over the Northern Great Basin study area. These include: 1) LANDFIRE Existing Vegetation Type (EVT) (USFS 2006), 2) Southwest ReGAP (Prior-Magee et al. 2007), 3) Northwest ReGAP (Kagan et al. 2008a, 2008b), 4) ShrubMap (USDI-USGS 2005), and 5) National Land Cover Dataset (NLCD) (Homer et al. 2004). All five have one thing in common; they use LANDSAT satellite data as the primary input for deriving the land cover data. Four of the five employ NatureServe's Ecological Systems (Comer et al. 2003) as the classification scheme. All five employ Classification and Regression Trees (CART) as the primary mapping algorithm. However, NWReGAP and ShrubMap both extensively modified their protocols to meet specific local phenomena. NWReGAP also extracted data from NLCD, LANDFIRE, and ShrubMap under certain criteria.

The evaluation of land cover data quality included six criteria: Accuracy, Precision, Relevance, Completeness, Consistency, and Currency.

- **Accuracy** – Discrepancy between the actual attributes value and coded attribute value
- **Precision** – Degree of details that are displayed on a uniform space
- **Relevance** – Qualitative measure of whether data chosen for a particular assessment are needed for that study
- **Completeness** – A measure of totality of features
- **Consistency** – The absence of conflicts in a particular database over time and space.
- **Currency** – Measures the temporal aspects of the database

Accuracy

LANDFIRE, SWReGAP, and NLCD were the only land cover maps that had complete data quality reports. ShrubMap performed a partial accuracy assessment for specific classes. NWReGAP only had accuracy assessment data available for forested classes. Only NLCD performed a full independent accuracy assessment for its 1992 product not the 2001 version; all other mapping efforts used various cross and internal validation techniques. Validation values are not reported for NLCD since that product did not meet other evaluation criteria mentioned below.

Error statistics reported in Table 1 were generated for LANDFIRE, SWReGAP, and ShrubMap by aggregating the full error matrices associated with each product into the classes used in this assessment (Sagebrush, Juniper, Salt Desert Shrub, and Other). Table 1 depicts the overall accuracy for the aggregated classes broken down by mapping zone. Aggregated accuracy estimates are based on available error matrices included in the final mapping reports.

Table 1. Overall accuracy.

Product	Mapping Zone	Overall Accuracy
LANDFIRE	Zone 9	76.4%
LANDFIRE	Zone 12	69.8%
LANDFIRE	Zone 17	63.1%
LANDFIRE	Zone 18	59.5%
SWReGAP	NV-1	66.9%
SWReGAP	NV-2	75.5%
SWReGAP	ID-5	88.6%
ShrubMap[1]	Basin and Range	95.0%
ShrubMap[1]	Owyhee Uplands[2]	100.0%
ShrubMap[1]	SE Idaho	83.5%
ShrubMap[1]	Snake River Plain	95.5%

Note: [1] ShrubMap's accuracy assessment is used as a surrogate for NWReGAP.

[2] The results for the Owyhee Uplands map zone have limited reliability due to the completeness and sample size of the error matrix.

ShrubMap and SWReGAP both outperformed LANDFIRE. The ShrubMap results seem exceedingly high compared to the other products. The ShrubMap results may be artificially high due to the compilation of the error matrices. This is not known for certain.

Precision

In examining the precision of a map, say vegetation type, we are evaluating the detail contained within the classification scheme. In the case of LANDFIRE, NWReGAP, SWReGAP, and ShrubMap, the classification scheme used is NatureServe's Ecological Systems. There are more than 200 classes of vegetation types for the Western US within the Existing Vegetation Type layer. NLCD on the other hand uses Anderson (1976) level 2 as its classification scheme and contains 24 classes across the US. NLCD failed this evaluation criterion.

Relevance

NLCD was not used in this assessment due to the need to characterize sagebrush vegetation types. NLCD classification scheme uses Anderson (1976) level 2 categories for its land cover information. All shrub types are lumped into a category called Shrubland. No other categorical refinement is available in NLCD. The other four land cover products were determined to provide relevant classes (namely discriminating sagebrush types from other shrubs) needed to support this assessment.

Completeness

Only LANDFIRE and NLCD cover the full extent of the study area. SWReGAP covers the states of Utah, Nevada, Colorado, Arizona, and New Mexico. NWReGAP covers the states of Oregon, Washington, Idaho, Montana, and Wyoming. ShrubMap did not cover the full extent of the Northern Great Basin and failed this evaluation criterion based on the incomplete nature of the spatial coverage.

Consistency

As stated above LANDFIRE, NWReGAP, and SWReGAP employ Ecological Systems and a consistent mapping protocol to generate their land cover maps. All five products break the mapping into ecologically similar zones. Within each zone, the land cover products are consistent. However, there are classification issues at the edges of mapping zones causing errors when doing regional (multi-zone) analyses. By aggregating the land cover data into broad categories this edge effect issues is somewhat ameliorated.

ShrubMap involved extensive experimentation to produce the most accurate broad scale map possible for select vegetation groups. However, by focusing on shrub types other vegetation types have very inconsistent reporting. The error matrices included in the mapping reports were not comprehensive for all land cover categories or consistent between zones. By way of example, there were 10 land cover class included in the error matrix report but more than 50 classes in the mapping product for the Owyhee Uplands map zone. For the SE Idaho mapping zone, there were 19 classes included in the error matrix and 48 classes in the map product.

Currency

All five land cover product are derived from the same source of LANDSAT imagery, which depending on the individual scene range from 1999-2003. At the time the NGB Assessment began none of the products had been updated to reflect land cover changes caused by human or natural disturbances. Since project inception, LANDFIRE and NLCD have had updates released but those updates were not factored into this assessment. All five land cover products' "Currency" criteria were rated as equal.

Summary

Based on these evaluation criteria and direct subject matter expert input from various stakeholders associated with this assessment, it was determined to use NWReGAP for the

Table 2: Data quality evalution criteria summary.

	NLCD	LANDFIRE	ShrubMap	SWReGAP	NWReGAP
Accuracy	NA	X	X	X	NA
Precision		X	X	X	X
Relevance		X	X	X	X
Completeness	X	X		X	X
Consistency	X	X		X	X
Currency	X	X	X	X	X

northern states, SWReGAP for the southern states, and LANDFIRE where neither of the ReGAP products have coverage. This decision was driven primarily by the perceived and documented error levels of the various products.

References

Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper 964. U.S. Government Printing Office, Washington, D.C. Available on-line *[http://landcover.usgs.gov/pdf/anderson.pdf]*.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA. 75 p.

Homer, C., C. Huang, L. Yang, B. Wylie, and M. Coan, 2004. Development of a 2001 national land cover database for the United States. Photogrammetric Engineering and Remote Sensing 70(7):829-840.

Kagan, J.S., J.L. Ohmann, M.J. Gregory, C. Tobalske, J.C. Hak, and J. Fried. 2008a. Final Report on Land Cover Mapping Methods, Map Zones 8 and 9, PNW ReGAP. Institute for Natural Resources, Oregon State University, Corvallis, OR.

Kagan, J.S., C. Tobalske, and J.C. Hak. 2008b. Final Report on Land Cover Mapping Methods, Map Zone 18, PNW ReGAP. Institute for Natural Resources, Oregon State University, Corvallis, OR.

Prior-Magee, J.S., K.G. Boykin, D.F. Bradford, W.G. Kepner, J.H. Lowry, D.L. Schrupp, K.A. Thomas, and B.C. Thompson, Editors. 2007. Southwest Regional Gap Analysis Project Final Report. U.S. Geological Survey, Gap Analysis Program, Moscow, ID.

United States Forest Service. 2006. LANDFIRE Existing Vegetation Type. USDA Forest Service, Missoula MT. *http://www.landfire.gov.*

USDI-USGS. 2005. Current Distribution of Sagebrush and Associated Vegetation in the Columbia Basin and Southwestern Regions. Forest and Rangeland Ecosystem Science Center, Snake River Field Station. *http://sagemap.wr.usgs.gov*